Chemical & Process Engineering

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Topics of the Month

Chemical engineering research added to C.R.L. programme

THE recommendation of the Cremer Report that more fundamental chemical engineering research should be undertaken and that special facilities should be provided has now been partly met. The Chemical Research Laboratory of the D.S.I.R. has agreed to add chemical engineering research to its programme. This step is announced in *Chemistry Research*, 1953, the annual report of the Chemistry Research Board, published last month. Apparently the proposal arose from a working party appointed by the D.S.I.R. to consider what immediate action could be taken in advance of any future implementation of the Cremer Report. Although the chemical engineering programme will be a modest one for a start, it is important in that it represents the first practical step taken on the recommendations of the Cremer Report. In doing this, the Government has given a small but significant lead to industry which is still considering what it can do to make possible more centrally organised research on the fundamental chemical engineering problems which affect so many industries. Too much should not be expected from the C.R.L. programme which, in any case, cannot really get under way until extra staff have been recruited and more accommodation provided. It is up to industry to make the next move.

Cheaper infra-red process control

AS one of the chief users and advocates of automatic process control, the chemical industry will take an especial interest in the new Automatic Control Division which the National Physical Laboratory propose to form. This Division is intended to work on the automatic control of experimental, industrial and administrative operations and the development of techniques and equipment for data processing and computation.

At the N.P.L. last month we saw one of the ingenious components for automatic control systems which are being developed. It is the Merton-N.P.L. diffraction grating. This grating is basically a slab of glass grooved with thousands of lines which diffracts light better than some of the best prisms. Working on the ideas put forward by Sir Thomas Merton, F.R.S., the N.P.L. are producing replica gratings at the cost of a few shillings compared with hundreds of pounds for a grating cut directly into glass. Heart of the system is the Merton nut which works on a special lathe used to score a metal cylinder with thousands of screw threads per inch. So accurate is the lathe that 30,000 threads per inch can be ruled. The threaded cylinder is used to make a plastic impression of the grooves, which is transferred to gelatin. The gelatin, laid on a glass slab, is vacuum aluminised to produce the finished replica grating.

One use for the gratings is to replace expensive prisms in infra-red control equipment. The grating diffracts the infra-red light transmitted through a chemical mixture and thus allows it to be examined for the absorption pattern of the molecular groupings. Thus hydrocarbons, phenols, etc., can be detected in a process flow and the proportion controlled. In effect, the apparatus—called a monochromator—is locked to detect the absorption pattern of the substance whose proportion it is desired to control.

High dispersion and resolution are obtained at low cost by the use of a replica diffraction grating with a selective filter, cheap spherical concave mirrors and simple slits. Two models have been developed at the N.P.L., differing only in size and in the type of infra-red-sensitive detector used. In one model, a lead selenide photoconductive cell is used and in the other a standard Golay pneumatic detector.

For use as a process control instrument, it is set on a wavelength at which the particular substance whose concentration it is designed to control has an absorption band. An increase or decrease in the concentration of the sample is then shown as a fall, or rise, in output in the meter reading. The concentration may then be controlled either manually or automatically by means of a servomechanism.

The monochromator is being commercially produced and the complete instrument is expected to cost no more than the prism needed for a highly sensitive conventional instrument.

Heats of combustion

ONE very important property of coal and petroleum products is the total heat which they produce when fully burnt; we already buy gas by the 'therm,' and no doubt logically should pay for coal in the same way. An exact knowledge of this 'heat of combustion' for pure organic substances is also important to the industrial chemist and process designer, for it may help him to forecast the probable result of a new chemical process.

The National Physical Laboratory make exact measurements of these heats of combustion, and calibrates standard materials by which the industrial user may check his own accuracy, in an apparatus simple in principle but of great refinement. A small weighed quantity of the substance, enclosed in a steel 'bomb' and surrounded by oxygen under pressure, is ignited electrically. The bomb is immersed in a sealed calorimeter containing vigorously-stirred water, and the rise in temperature of this water measures the total heat produced in the combustion. The calorimeter is in an enclosure whose walls are kept constant in temperature to within a thousandth of a degree during the experiment, and everything is designed so that conditions are exactly reproducible and measurable. The rise in temperature of the water has to be measured with electrical thermometers to within one ten-thousandth of a degree to give the necessary accuracy in the final result; and, to check that no water is lost from the calorimeter by evaporation, it is weighed to an accuracy of a few parts in ten million. The apparatus is calibrated by liberating within it a similar quantity of heat, measured by passing an electric current through a resistance for an accurately known time.

The Chemical Research Laboratory of D.S.I.R. co-operates in this work in the precise analysis of the products of combustion after each experiment and in the supply of the specially pure organic materials, whose heats of combustion are at present being measured.

Selenium from pyrites roasters

THE possibility of recovering selenium from the dusts and wastes arising from the flash roasting of pyrites in the manufacture of sulphuric acid is being studied by the Chemical Research Laboratory. Examination of the dusts and sludges from various parts of purification plants supplied by three firms has shown that the selenium tends to pass through dust precipitators and cyclones, but that a concentration may occur in the wash systems. The richest material has been a sludge formed when the sulphur dioxide was washed with weak sulphuric acid. Various fractions of this sludge contained from 7.4 to 54% selenium. Such material has been obtained from only one plant, but it is probable that a similar product will occur at other plants using a dilute acid wash.

Difficulties were experienced in obtaining consistent analytical results when using published methods and, therefore, a considerable effort was directed to securing analytical procedures more suitable to the variety of products examined and the wide range of their selenium contents which, in some cases, were as low as 5 p.p.m. For such small amounts a colorimetric method was found to be best and this in turn called for a quantitative separation of the selenium from other elements present in the sample, some of which might interfere in the final determination. To ensure the complete recovery of minute amounts of selenium down to 10 to 20 μg., the procedure was adopted of precipitating it in the presence of added arsenic, which acts as a collector. Much attention was also paid to the best method for decomposing the samples. For pyrites a wet attack was used, in which 2 g. of the ore was treated with 15 to 20 ml. of a mixture of three parts by volume of nitric to one part of hydrochloric acid.

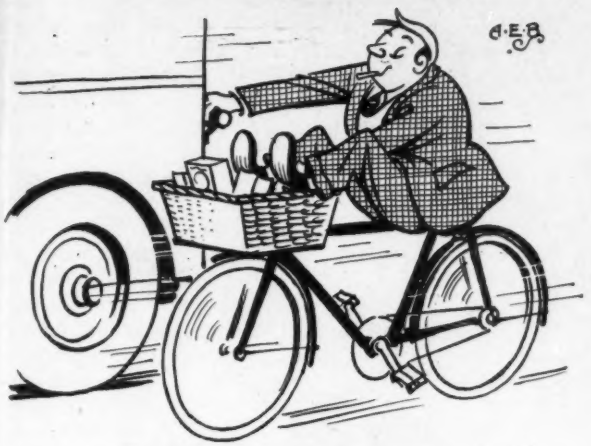
The results obtained so far from the systematic study of dusts and wastes suspected of containing selenium indicate a hitherto untapped and quite considerable source of this valuable element, which is urgently needed as a rectifier for electronic equipment.

Low-alloy steels defy corrosion

AN important discovery which should help to cut down considerably the costs of corrosion has been made by the Corrosion Section of the British Iron and Steel Research Association. It has been found that, under conditions of atmospheric exposure, the corrosion rate of steels containing small percentage additions of chromium, copper and nickel is not more than one-third of that of ordinary mild steel. When immersed in sea water, small additions of alloying elements are not so beneficial; the corrosion rate is halved by the addition of 3% chromium and there are indications that aluminium and beryllium additions may be of value. Differences in carbon content had little effect on the measured corrosion rate and there was a negligible effect due to heat treatment. Cast iron corroded less rapidly than unalloyed low-carbon steel in the atmosphere but at about the same rate when immersed in sea water.

A fuller summary of the work of B.I.S.R.A.'s Corrosion Section, reported in the Association's annual report for 1953, appears in the current (June) issue of *Corrosion Technology*. This journal, hitherto a supplement to CHEMICAL & PROCESS ENGINEERING, is now published separately. The June issue contains articles on 'Paint *versus* Corrosion,' 'Cathodic Protection' and 'Maintenance of Corrosion Resistance of Welded Stainless Steel'; a report

Comical Engineering Terms



"CONSERVATION OF ENERGY"

of the work of the Corrosion Group of the Chemical Research Laboratory; and many other articles and notes on all aspects of corrosion. Subscriptions (40s. a year—12 issues —and £5 for three years) should be sent to the Circulation Department, *Corrosion Technology*, Stratford House, 9 Eden Street, London, N.W.1. Until July 31 a special founder-subscriber rate of 60s. for a three-years subscription is available.

'Figure-of-eight' mixer

A NEW mixing apparatus, developed by Ministry of Supply scientists, is claimed to be capable of effecting intimate mixing of small quantities of powdered solids of substantially different densities. It is of particular use in a laboratory where large numbers of samples of mixed powders have to be prepared—a job which in the ordinary way would probably be carried out by hand.

To ensure perfect mixing it is necessary to subject such powders to more than mere shaking. The ideal arrangement is to contrive for them to be agitated in two planes, and the effect is obtained in this instance by imparting to them a rapid 'figure-of-eight' movement.

The powders to be mixed are first put into small glass tubes or capsules, which are stoppered. These tubes are then inserted in a carrier, which takes the form of a block having suitable horizontal cavities for accommodating the tubes—four being a convenient number. When in position, the tubes are held securely by the closing of a hinged lid fitted with rubber pads which press against the corked ends.

A transverse slot through the carrier block at right-angles to the axis of the tubes enables it to be mounted on a horizontal spindle carried by brackets affixed to a base plate. From the centre of the block extends a horizontal rod which is pivotally connected to a counterbalanced crank, driven by a spindle and pulley which are also horizontally mounted on the base plate by means of brackets. When the crank is rotated, a combined reciprocating and rocking motion is imparted to the carrier: for, in addition to being oscillated on the spindle, it is also urged to and fro at the same time. The resulting 'figure-of-eight' movement is claimed to give perfect mixing of the contents of the tubes.

This invention is described in the National Research Development Corporation's *Bulletin*, a new publication aimed at making industry aware of inventions resulting from research carried out with public funds. The mixing apparatus (Brit. Pat. 684,615) was developed in the Chemical Inspection Department of the Ministry of Supply by R. Franklin, H. Pickering, A. B. Timms, A. Townley and F.J. Woodman.

Natural gas: world developments

IF the Gas Council's efforts to find natural gas in Britain needed any encouragement other than the high price of coal, it would be provided by the example of Pakistan, whose fuel position might be revolutionised through development of the natural gas resources recently discovered there. Plans are moving ahead rapidly to lay 350 miles of 16-in. pipeline to carry the gas from Sui, in Baluchistan, to Karachi at an initial cost of £9 million. The gas will be available for industrial consumption in Karachi and Sukkur (Sind) about the middle of next year. The proved reserves of gas at Sui are reckoned to be enough to supply 100 million cu.ft./day of gas for 60 years.

From North America comes news of more natural gas projects. An ambitious Canadian scheme for piping natural gas from Alberta to central Canada in much the same way as Alberta oil, hangs on negotiations between the Government and private enterprise. The pipeline, costing perhaps $300 million, will take two years to build; work might start in the summer. In the United States, where there are already 400,000 miles of pipelines for natural gas, some $2,500 million will be spent on natural gas projects over the next three years. One proposal is the construction of a giant pipeline which could supply oil to the east coast in the event of war, earning its keep in peacetime by carrying natural gas. Obviously there are snags, including the difficulty of finding consumers for the gas when it is known that the supply would be cut off in wartime.

In Europe, where supplies of coal and petroleum are not so plentiful as in North America, there is a need to find and exploit more natural gas deposits such as those discovered in the Po Valley in Italy in recent years, or those which are being put to such good purpose by the chemical industries of south-west France. Developments will come all the quicker if governments and other interested parties are kept well informed about what is happening in other countries around them, and here a new study that is being undertaken by the O.E.E.C., on the search for and exploitation of crude oil and natural gas in member countries, should help. The main subjects to be studied are geological information, mining and fiscal regulations, current operations and operating resources.

In the U.K., the latest development in the Gas Council's five-year search for natural gas is deep drilling at Cousland, near Edinburgh. The presence of natural gas in this area is known as a result of borings made before the war, but further drilling is necessary to establish the extent of the reserve. This is the first deep drilling to be undertaken by the D'Arcy Exploration Co. on behalf of the Gas Council, although preliminary survey work has been proceeding for some weeks in Yorkshire, Lincolnshire and Sussex.

At Grosmont, north Yorkshire, where methane was found at a depth of 4,800 ft. in a borehole drilled by I.C.I. as contractor to D'Arcy, assessment of the commercial possibilities is still going on. If there is enough gas it will be piped to the I.C.I. factories at Billingham and Wilton, about 30 miles away.

Air pollution and odour control

HOW American engineers overcame the problem of air pollution involved in the use of air-blown sulphuric acid concentrators, the effluent from which contains acid mist and sulphur dioxide, was told to the Institution of Mechanical Engineers in London recently by Mr. Frederick S. Mallette of the American Society of Mechanical Engineers. Attempts were made to control the acid mist with low-pressure sprays, bag filters and an acid fume furnace, but the only successful method found was a high-pressure water fog system. In a pilot model, mist removal efficiencies as high as 95% were achieved at a spray pressure of 500 lb. and a water rate of 6 gal./min.

A plant-scale model increased efficiency even over the pilot model. The value of sulphuric acid recovered and heat saving amounts to about $55,000 per unit per year. The net operating cost is about $5,000, or two cents per ton of acid concentrated for the process concerned.

Mr. Mallette also discussed the odour problems which occur mainly during the drying operations of both synthetic and reclaimed rubber. A new method to cope with this problem was catalytic oxidation which, he said, had also been used successfully in the metal decorating industry, for incinerators, in coffee-roasting plants, in wire enamelling ovens, in the manufacture of phthalic anhydride, for gas-fired driers on high-speed printing presses, and in the cooking of resins and varnishes.

Chemical effluent research

THAT biological treatment of metal cyanides in industrial waste waters might prove cheaper and less troublesome in some cases than the chemical methods used at present is one of the possibilities raised by recent studies of the Water Pollution Research Board, D.S.I.R. It had previously been shown that, although the efficiency of treatment of sewage by biological filtration is at first reduced when very small concentrations of metallic cyanides are added to the sewage, this effect soon disappears. If the amounts of cyanide added are gradually increased, concentrations of about 100 p.p.m. are eventually tolerated without causing much deterioration in the quality of the effluent. It has now been found that some metallic cyanides (potassium cyanide and the complex cyanides of zinc and cadmium) can be destroyed by biological action in a percolating filter without the addition of sewage or any other nutrient. For example, when a solution containing potassium cyanide equivalent to 100 p.p.m. HCN was treated, the concentration of HCN in the effluent did not exceed 1 p.p.m. With the complex cyanides of copper, nickel and iron, destruction is much less complete. It is possible that biological treatment of some types of waste water from electro-plating, and of the washing waters produced when steel is hardened by dipping in molten sodium cyanide, might be both cheaper and more convenient than the chemical methods at present used. It is hoped to carry out tests with pilot plant.

At the sewage works at Stivichall, near Coventry, experiments have been continued on the treatment of sewage to which was added spent liquor from the gas works at Hinckley, where hot gas is treated in electrostatic detarrers. Addition of about 2.5% by volume of the spent liquor caused little deterioration in the quality of the sewage effluent. With ordinary spent liquor—such as that from the Leamington gas works with which experiments were carried out previously—so high a concentration would, of course, cause a very marked deterioration. The Hinckley liquor, however, does not contain retort-house liquor, which is kept separate and is disposed of on land. When an appropriate amount of retort-house liquor was added to the spent liquor the effect of the mixture on sewage treatment was greater. Even so, the effect appears to be much less than was caused by the same proportion of mixed liquor from Leamington, where the hot gas is not treated by electrostatic precipitation.

Experiments on anaerobic fermentation of 'black liquor' from the kiering of cotton have been continued on a pilot-plant scale. With a period of digestion of four days at 30°C., the biochemical oxygen demand of the liquor (which had previously been neutralised) was reduced by about two-thirds. The gas evolved contained nearly 70% methane.

These and other experiments are described in the section on industrial wastes in a new booklet: 'Water Pollution Research, 1953' (H.M.S.O., 2s. 6d.). Other sections of the booklet are concerned with water treatment, sewage, the effects of pollution, a survey of the Thames Estuary, and automatic equipment developed in the Board's laboratory.

New plans for synthetic rubber

WHILE there is still considerable speculation about the separately announced decisions of I.C.I., Monsanto and the Dunlop Rubber Co. to make synthetic rubber in the United Kingdom, some interesting things are happening in the U.S. and elsewhere concerning this increasingly important commodity. Contrary to some earlier predictions, great interest has been shown by American private industry in the arrangements for selling the Government-owned synthetic rubber plants, and bids, which were received up to May 27, came thick and fast from rubber, chemical and petroleum concerns. Even firms not directly concerned with the manufacture of synthetic rubber or its component materials at present showed interest.

The rapid growth of U.S. synthetic rubber can be judged from the fact that in 1952-53 the Reconstruction Finance Corporation, which runs the plants, made a net profit of $60 million, against $16 million the previous year. Anticipating a huge market for butadiene when the synthetic rubber plants pass out of the Government's hands, private interests plan to set up a 100,000-tons-p.a. plant to produce butadiene from refinery butane in Texas. Initial plans are said to call for the construction of a 25,000-tons-p.a. unit.

To stimulate exports, primarily to Europe, the U.S. Government has reduced the freight charges on export shipments of GR-S type synthetic rubber. Britain should benefit from this, because this year up to 15,000 tons of synthetic rubber may be imported from the dollar areas.

In Canada, the chairman of the Goodyear Tyre & Rubber Co., of Akron, Ohio, said recently that world production of synthetic rubber must be increased to make up the difference between world production of natural rubber—estimated at 1,700,000 long tons p.a.—and world consumption of rubber, which is some 600,000 tons more.

In West Germany, the plan to set up a plant for the manufacture of 30,000 tons p.a. of synthetic rubber from French alcohol imported at a reduced price has been postponed indefinitely. The project, mainly supported by Chemische Werke Huels A.G., at present West Germany's only manufacturer of synthetic rubber, would have necessitated special tax and duty concessions by the Government to enable production at a price competitive on the world market.

SYNTHETIC FATS, SOAPS AND ALLIED PRODUCTS

I. Development and Potential

By John Seaman

The vast increase in petroleum refining, notably in Great Britain, has produced large quantities of by-products which, because of progress in technology, it is possible to convert into a range of higher-grade products currently based on glyceride oils and fats. The commodities which it is thus possible to obtain from petroleum are synthetic fats, starting from slack wax and propylene, synthetic detergents, including soaps, starting from kerosine range distillates and waxes, and other products for which the base materials are residues from the foregoing major processes. Schemes for thus utilising refinery by-products are now being considered in this country and it is the purpose of this series of articles to give the technical and economic background. This first article introduces the subject. The second will discuss materials and processes, and the third will consider the economic aspects.

Economic factors

IT is well established that the world demand for edible fats is limited to about one-quarter of the potential demand, owing to lack of purchasing power of the majority of the world's population.

During the past two decades there has been a significant trend towards the retention of oilseeds and other fatty raw materials for primarily edible use in the countries of origin, *e.g.* India and China. Consequently, international trade has fallen absolutely, which represents a much greater fall in relation to a rapidly increasing world population. The most obvious consequence of these trends has been an increase in prices by about 500% since 1930.

In view of this trend, the attentions of chemists and industrialists has been turned to the possibilities of using alternative base materials in vastly greater supply, notably petroleum and Fischer-Tropsch waxes. These consist predominantly of hydrocarbons of a paraffinic nature which, by the use of appropriate techniques, can be converted to fatty acids, alkyl and alkyl aryl compounds and other intermediates for oils and fats, detergents, paint and similar important commercial substances.

Present industrial organisation

The vast bulk of trade in fatty oils and their derivatives is in the hands of not more than ten organisations throughout the world. The scale of their processing operations may be judged from the fact that the two outstanding companies each has a turnover, in this section of their activities, exceeding £500 million p.a. Until quite recently virtually all the products of these companies have been obtained from natural oils and fats and by traditional methods. The main reason for that state of affairs was that alternative base materials, *e.g.* for such major commercial substances as soaps, were not available or could not, at that time, be produced economically in sufficient quantities to provide a sufficiently solid basis for any large-scale conversion of equipment and factory processes.

However, over the past five years, a vast increase in output of synthetic detergents, notably in the U.S.A. and Great Britain, has changed the outlook fundamentally. The bulk of these synthetic detergents has been based on petroleum derivatives and their use has, therefore, released corresponding quantities of natural oils and fats. By the best modern methods, the greater part of these can be processed to acceptable edible standards and so augment supplies in this vital sector. In this way the increasing use of synthetic detergents has established the main lines of future development, the essential result of which is likely to be the progressive elimination of the use of basically edible raw material for inedible products.

Technology

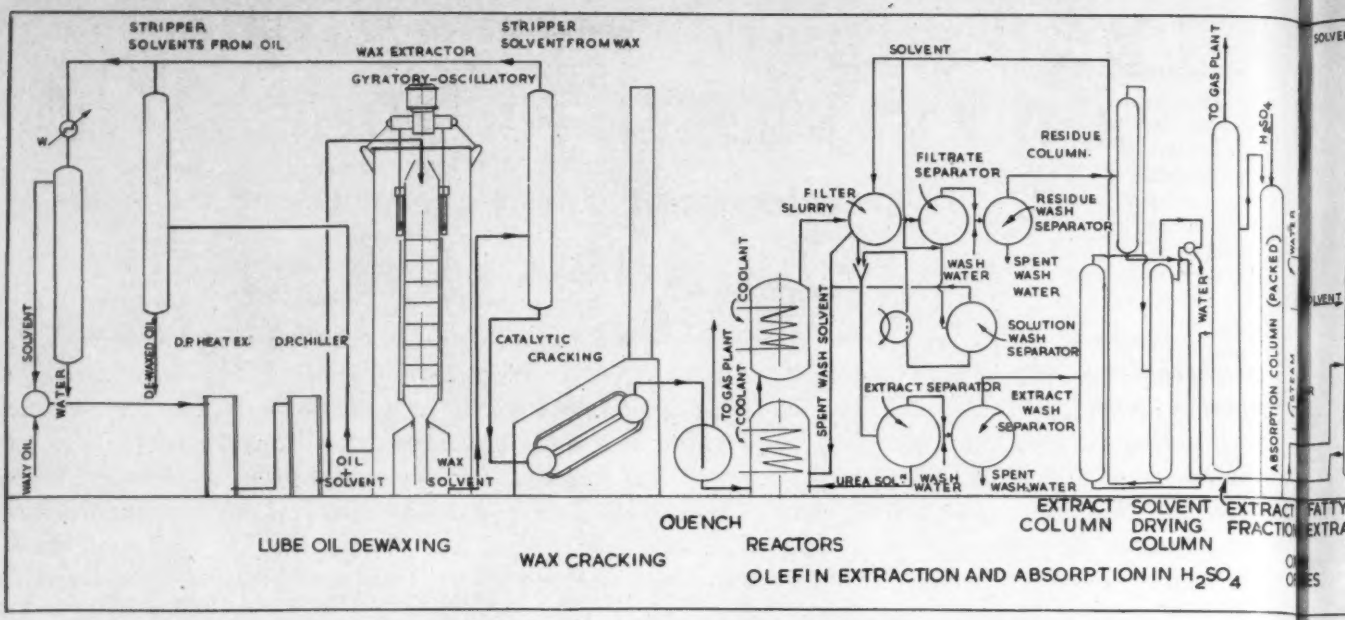
Parallel with the increasing use of natural oils and fats for human nutrition has been the gradual improvement of edible fats from other sources, *e.g.* Fischer-Tropsch and petroleum waxes. To establish the basis of practical achievement upon which future progress can be visualised, it is convenient to survey, very briefly, the work done in this sphere in Germany which led to substantial outputs of synthetic edible fats during the second world war. Although these commodities had serious defects in comparison with butter and margarine, it was definitely established that they were partially assimilable through human metabolism and were capable of achieving some of the calorific and other functions of natural fats. Some German physiologists claimed that they were 90% assimilable, but later research has cast considerable doubt on their accuracy.

These synthetic fats were a near approach to complete synthesis. The essential process was the formation of carbon monoxide by the partial combustion of such cheap fuels as brown coal and lignite, and its reaction with hydrogen, mostly in steam, to form hydrocarbons and their oxygenated compounds. The primary purpose of the process was to produce liquid fuels and lubricants, but it was found that, by adjustments in operating temperatures, pressures, catalysts and other factors, high molecular weight substances such as waxes could become the main product.

By heating these waxes, known as gatsch, with sodium carbonate and a potassium permanganate catalyst, under relatively high pressure, and spraying acetic acid into the reaction chamber, substantial yields of higher fatty acids were obtained. The fraction containing chiefly C_{10} to C_{20} acids was esterified with glycerol in the presence of 0.2% metallic tin and under 2 mm. absolute pressure. The fundamental objection to the final product, for edible use, was the presence of fatty acids containing an odd number of carbon atoms in the molecule, in almost equal proportion with those of even number. In natural oils and fats the constituent fatty acids are almost entirely of even numbers of carbon atoms and many eminent nutritionists assert that those of odd carbon number are not assimilable by the human digestive process. This objection to synthetic fats has now been overcome, since it has been found possible to produce almost any desired combination of fatty acids excluding those which are not considered assimilable or unsuitable for any other reason.

Correlation of processes

The starting materials for the range of



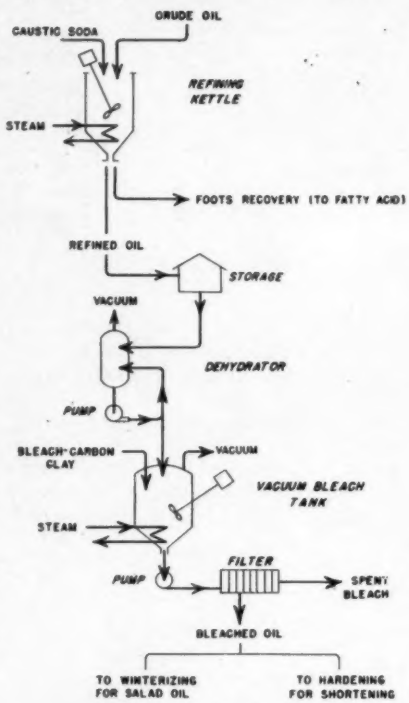
Process for extraction of waxes from lube oils and their conversion to secondary alkyl sulphates and fatty acids. Associated processes for b

products under consideration are largely derivatives of petroleum, *e.g.* slack wax from lube oil distillates and such gaseous substances as proplyene and ethylene. All that need be said of the latter is that they are essential by-products of cracking processes and therefore in abundant supply. Typical of their industrial application is the manufacture of about 20,000 tons p.a. of synthetic glycerin from propylene at the Houston, Texas, factory of the Shell organisation.

The vast proportion, by weight, of the range of products now being considered is derived from the middle and heavy fractions of petroleum. As a typical example of an application which has already reached commercial-scale production may be cited the case of the alkyl aryl sulphonate type of detergent base material. One of these, *Nacconal NR*, is made by chlorinating a C_{12} to C_{16} distillate and combining the chlorinated hydrocarbon with benzene with the aid of aluminium chloride in a Friedel-Crafts reaction with the elimination of hydrogen chloride. The alkylate is then purified by distillation and sulphonated, preferably with one sulphonic group in the molecule. Neutralisation with soda ash yields sodium alkyl benzene sulphonate and sodium sulphate. The content of the latter is brought up to 55 to 65% of the total solids and the compound is drum- or spray-dried to the desired form of a white powder.

Another derivative of petroleum which is base material for the present series of processes is the slack wax, *i.e.* a mixture of wax and oil, produced in the normal manufacture of high-grade lubricants of low pour point. Since this is necessarily a by-product, a nominal figure of the order of £10 per ton can be assigned as its value. The actual figure, of course, is dependent upon the particular process and costing system of the refinery, but it will be of the order given.

The slack wax which is recovered from lube oil and wax distillates in refineries consists mainly of straight-chain hydrocarbons in the range from C_{18} to C_{60}. To convert this material to currently saleable solid forms involves considerable processing, chiefly to remove the neutral oil which



Glyceride oil refining.

is intimately associated with the agglomerated wax crystals. This is achieved by a process known as 'sweating,' in which, by gentle heating, curled flakes of wax are induced to open and so release trapped oil. This is followed by filtration either by pressing or rotary vacuum types of filter. Some indication of the extent of processing required is given by the price of the finished product, *i.e.* about £80 per ton, although this, of course, includes marketing charges and profit.

One of the major economic advantages of using the slack waxes as base materials for the commodities previously specified is that the above processes are eliminated. In this application the first operation is to pass the waxy oil through a special type of strainer and the extract from it is the raw material for the process. It is first passed through a tubular heat exchanger, in which it acts as coolant to the oilstock which is to be dewaxed, and thence pumped to the catalytic cracking stage.

The main process will be dealt with in Part 2, but it is necessary to give the outline here to establish its relationship to the overall technological development and the general economics. The main stages are:

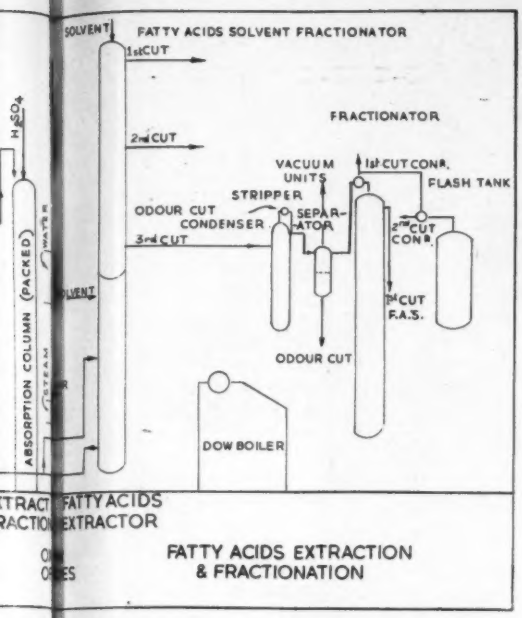
(1) Controlled cracking of the feedstock, with recycling, resulting in the following approximate composition of the treated material:

Gaseous: 2% by weight.

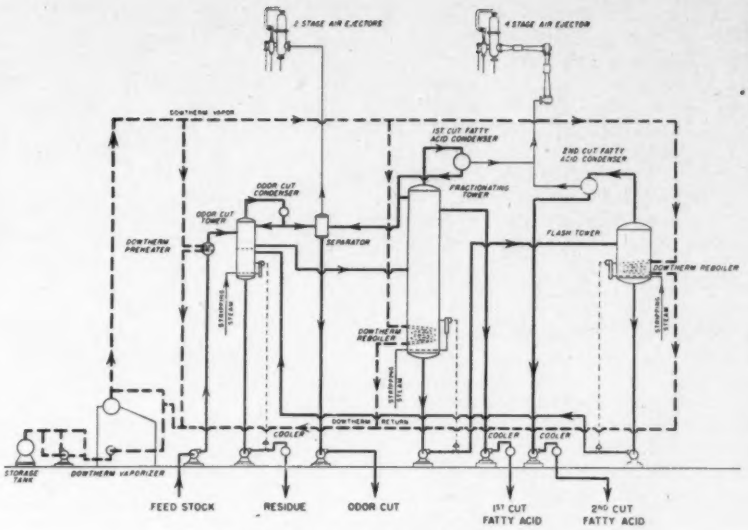
Liquid:

(*a*) 25% unsaturated hydrocarbons preponderantly olefinic in the range C_{10} to C_{20}. By absorption of the olefins in sulphuric acid, base material for synthetic detergents is produced.

(*b*) 75% mainly saturated



s for b and synthetic bases are shown in other flowsheets.



Fatty acid fractional distillation.

hydrocarbons in the range below C_{30}.

(2) Fractionation of the paraffinic proportion to yield, mainly, a mixture in the range C_{20} to C_{30} and preponderantly of even carbon atoms.

(3) Continuous oxidation of the above major fraction to produce a mixture of fatty acids in the range C_{10} to C_{20}, *i.e.* most suitable for the preparation of edible fats and soaps. The fatty acids containing even numbers of carbon atoms in the molecule are subsequently separated for edible purposes, the remainder being used in soap manufacture.

(4) Conversion of lower fatty acids into the above range by condensation with ethylene to yield, particularly, the range of higher fatty acids most suitable for edible fats.

Blending with upgraded natural materials

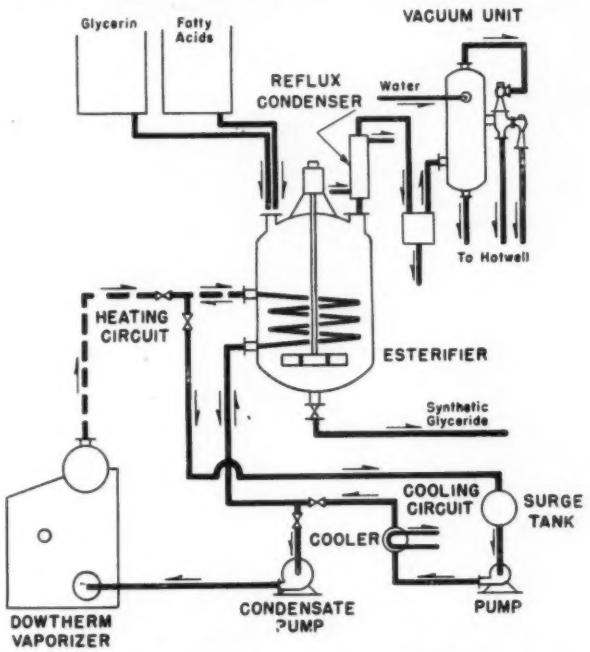
In the opinion of the writer the most logical policy in the use of synthetic fats is to blend them with upgraded natural fats. As detergents are increasingly made from inedible base materials, ever-increasing quantities of the lower grades of natural oils and fats will become redundant in their traditional functions. These are essentially the same material as the edible grades, but, owing to hydrolysis and other forms of decomposition together with many other forms of contamination, they have fallen below the standards accepted as minima in human food.

The processes whereby natural oils and fats, hitherto generally regarded as inedible, can be freed of contaminants and, to some extent, chemically rebuilt are too numerous and complex for treatment here. However, it can be stated, emphatically, that the greater part of the fatty materials at present used for making soap can be made quite suitable either for incorporation in bulk fats such as margarine or can save large quantities of such natural materials at present diverted to lesser functions in food processing for which synthetics are quite adequate.

By careful formulation, mixed natural and synthetic fats can even be superior to the purely natural substance for some purposes. The reason for this is that natural fats contain minute quantities of unstable substances inseparably associated with the natural conditions of synthesis. Most of these, such as gums, mucilages and other non-fats, are removed in the refining processes, but even the almost infinitesimal quantities which remain can promote deteriorating actions vastly disproportionate to their relative weight. In effect they are catalysts.

For this reason and others, natural fats deteriorate far more rapidly than synthetics in such operations as deep frying. In such cases, where the fat enters into the final composition of the foodstuff in very minor proportion, it is quite permissible to take advantage of the superior resistance to deteriorating actions of the synthetics.

Production of synthetics in the range specified and in quantities appropriate to



Esterification of fatty acids with glycerin.

the vast unsatisfied need involves the creation of a new major industry which will take many years to build. It is clearly necessary to regard synthetics as supplementary to the present supplies of fatty materials rather than as substitutes. Only when the output of synthetics has satisfied demand for inedibles will it be necessary to include them in large proportion in such commodities as margarine. In the meantime, it can reasonably be assumed that the edible quality of the synthetics will have been still further improved.

Comparison of processes

It will be observed that the major processes involved in converting petroleum waxes to the finished products specified are quite well known and have been carried out industrially on a large scale. They represent a more rational solution to world supply difficulties than past policies. Instead of *breaking down* complex chemical structures created in nature for food to provide less vital commodities, the essential principle is to *build up* from such simpler and vastly more abundant raw materials as petroleum and coal.

The most apt illustration of the industrial application of the principle is found in the case of synthetic glycerin. On lines essentially similar to those followed by Friedel and da Silva over 80 years ago, about 10% of world supplies are now made by building up from propylene instead of breaking down glycerides. A parallel development of the work of Staal in producing fatty acids, in the same period, has now brought synthetic soaps and fats to the same commercial status, potentially, as synthetic glycerin now firmly holds.

Even now, misconceptions on economic aspects may continue to be a barrier to progress. It is, therefore, highly desirable to establish that synthetics can be produced at considerably less cost than the equivalent products of natural oils and fats. This aspect of the subject is treated at length in Part 3, but an outline here is necessary to ready understanding of Part 2.

The matter can be resolved into two main questions:

(1) What are the comparative costs of detergents of equal properties derived respectively from petroleum and from natural oils and fats?

(2) What are the comparative costs of usable grades of synthetic edible fats and equivalent grades of the natural material?

Since the synthetics are not, at present, being considered as substitutes for the highest grades of natural fats such as are used in the manufacture of margarine, a figure of £100 per ton can be taken as the market price of the natural base material. The ultimate raw material for the synthetics is priced at about £4 per ton.

World output of visible, *i.e.* dissociated oils and fats, is about 20 million tons p.a., whilst that of crude petroleum exceeds 650 million tons annually. The significance of this, for the present purpose, is that market prices of natural oils are generally about three times their cost of production, owing to the relation between supply and demand, whilst petroleum crude prices include a comparatively small profit margin.

Since there is such a vast disparity between costs of the alternative base materials, it is clear the the present questions can be further resolved by consideration of the processes involved in converting the respective base substances into marketable finished products, notably soaps and edible fats.

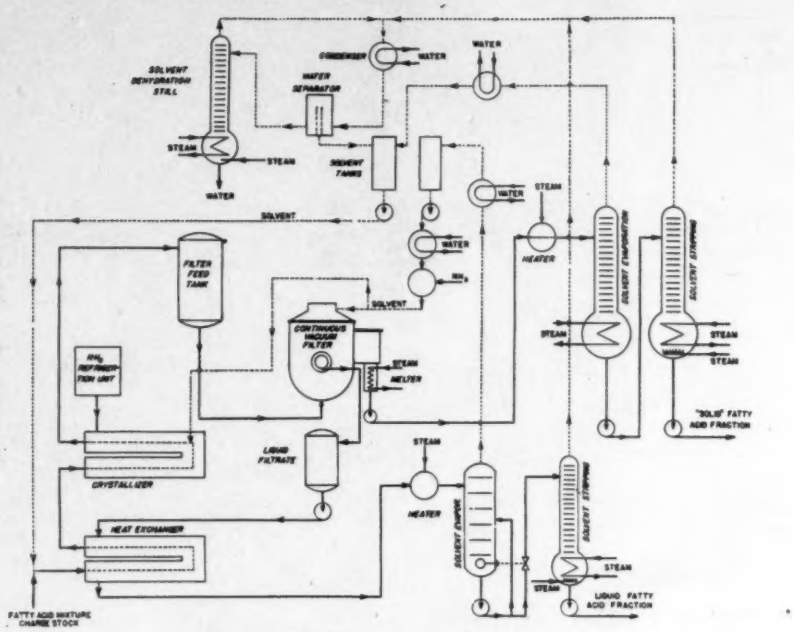
To avoid the unnecessary complication involved in including the whole range of products derived from crude petroleum, it is convenient to assign a figure to just one of these, namely wax. The type of wax required is mainly that extracted from lube oil distillates and this constitutes about 4% by weight of the crude.

Being a necessary by-product of the lubricant section of the refinery, this small fraction of the total output would carry practically none of the overheads and its value would, therefore, be little more than that of the feedstock. A figure of £10 per ton would be quite adequate.

Thus the alternative substances from which practically identical long-chain hydrocarbons can be derived are glyceride oils and fats, costing £100 per ton, and lube distillate waxes, to which a cost of £10 per ton has been assigned.

From natural fats the normal major products are edible fats, soap and glycerin. As indicated, chemically equivalent commodities can be obtained from the waxes, although vastly more complex processing

(*Concluded on page 175*)



Fatty acid fractional crystallisation.

Table I. Processing of Natural Oils and Fats and Petroleum Waxes and Fatty Acids

To Edible Fats	
Natural oils and fats	*Petroleum waxes*
Neutralisation (de-acidification) by stripping of free fatty acids or treatment with caustic soda or soda ash.	Steam stripping of solvent.
Deodorisation by steam stripping under vacuum.	Partial removal of oil.
Bleaching by adsorbent earths, activated char or chemical bleaches.	Cracking of slack-wax.
Straining to remove bleaching earths, colour bodies, etc.	Urea removal of olefins.
Filtration by filter presses or rotary vacuum filters.	Fractionation of paraffins.
	Oxidation of selected fractions.
	Fractionation of fatty acids.
	Removal of odd carbon fatty acids.
	Esterification with glycerol.
	Deodorisation by steam stripping.

To Soap and Glycerin	
Natural oil	*Selected fatty acids from above*
Soap	Neutralisation
Saponification with caustic soda or hydrolysis.	Propylene from wax cracking.
Evaporation of sweetwater or neutralisation.	Chlorination.
Distillation of crude glycerin or evaporation of sweetwater.	Conversion of alkyd chloride to crude glycerin.
Filtration of glycerin or distillation.	Evaporation.
Filtration of glycerin.	Distillation.
	Filtration.

OIL GASIFICATION

By R. Long, Ph.D., Assoc.M.Inst.Gas.E.

(Department of Chemical Engineering, University of Birmingham)

In recent years considerable interest has developed in processes for the gasification of oil, particularly heavy oil, and several new processes have appeared. The reasons for this interest are probably twofold, namely the shortage of coal and the building of large new refineries in this country, leading to the availability of considerable quantities of residual fuel oil. The various processes now available are described in this article.

THE manufacture of carburetted water gas is, of course, a widely-used process in the British gas industry and this process is particularly useful for meeting peak loads since the plant is very rapidly started up. In the manufacture of carburetted water gas, blue water gas is first produced by passing steam through a deep fuel bed of hot coke and this gas, with a calorific value of about 300 B.Th.U./cu.ft., is enriched by passing through the carburetter and superheater in which oil is injected and evaporated, and cracked respectively. The process is necessarily an intermittent one, for the endothermic steam/carbon reactions cause a rapid fall in the temperature of the fuel bed and an air blow through the plant must alternate with the steam run.

The nature of the oil plays an important part and usually gas-oil, a distillate fuel, is employed. The carburetter and superheater are filled with a chequer work of refractory bricks heated to about 750°C. during the blow period. R. H. Griffith[1] has pointed out that the yield of gas from the oil depends upon the temperature of cracking, the rate of oil injection and the composition of the oil used. Griffith has also shown that a knowledge of the proportion of open-chain paraffin and unsaturated hydrocarbons gives a useful indication of the thermal yield of permanent gas, for these hydrocarbons are more valuable than the aromatics or naphthenes for purposes of cracking to permanent gas. The gasification of the oil occurs in an atmosphere of blue water gas which contains some 50% by volume of hydrogen, and the absorption of some hydrogen has an influence on the gasification.

Because of the demand for gas-oil fractions as desirable cracking stock for motor fuel preparation, heavy residual fuel oil has for many years been cheaper than gas oil in the U.S.A. and consequently much effort has been devoted in that country to methods of using these heavy oils for gasification. Heavy oils have certain serious disadvantages, however. Their high viscosity means that heated pipelines and storage tanks are required, and ordinary carburetters cannot be used, for the residue of carbon would, on accumulation, soon render the set inoperable. It has also been pointed out that reaction between hydrogen sulphide in the gas and hot deposits of carbon results in the formation of carbon disulphide in the gas.[2]

One of the most popular methods[3] of avoiding serious difficulty is by the use of an empty carburetter into which the heavy oil is sprayed in a finely divided state using a high-pressure mechanical spray nozzle. The carbon residue is deposited on the sides and floor of the carburettor, from which it must be removed, partly by burning off during the blow period and partly by periodical removal by mechanical means; often cleaning must be carried out daily. In another process[3] most of the oil is sprayed on to the top of the coke fuel bed in the generator and only about one-fifth goes into the carburetter, which contains a heating surface of large refractory tiles set far apart.

The calorific value of C.W.G. can be varied by varying the amount of oil introduced,[4] but as the resulting gas has a higher specific gravity than coal-gas and a higher burning velocity, the proportion which can be mixed with coal-gas is limited if adjustments to appliances are not to be made necessary.

Various processes have been devised[5, 6] for the gasification of oil alone as a means of producing town gas rather than its use merely to enrich blue water gas produced from coke. These processes fall into three groups which may be summarised as follows:

(*a*) *Alternate 'blow and run' processes.*
1. Pacific Coast oil gas process.
2. (New) Jones oil gas process.
3. Twin-generator process.
4. Refractory-screen process.

(*b*) *Partial combustion in air or air and steam.*
1. Dayton process.
2. G.E.I.M. process.
3. G.L.C.C. process.

(*c*) *Catalytic gasification processes (which, however, still require a 'blow and run' cycle).*
1. Segas process.
2. O.N.I.A.-G.E.G.I. process.

These will be discussed briefly in turn, but certain general features must be mentioned at the outset. If a gas produced from oil is to be distributed mixed with coal-gas then it must be sufficiently similar in its combustion characteristics (calorific value, specific gravity, burning velocity, etc.) that the behaviour of appliances on the district is not disturbed. Some of these

Table I. Typical Analyses of Gases Obtained in Various Processes*

Process	C.W.G. (400)[4]	C.W.G. (500)[4]	Pacific coast[5]		Jones[8]	Twin-generator[9]	Dayton[5]		G.E.I.M.[6]	G.L.C.C.[12]	Segas[16]	O.N.I.A.-G.E.G.I.[18]		Typical town gas[16]
			Single-shell	Two-shell			450	500				450	500	
Fuel used	Coke + gas oil	Coke + gas oil	Refinery oil residuum		Fuel oil	Fuel oil	Light fuel oil		Gas oil	Gas oil	Fuel oil	Fuel oil		Coal
Gas composition (% by vol.):														
CO_2	4.8	4.1	2.1	4.8	3.2	5.8	5.9	6.1	3.0	2.7	9.4	7.1	5.5	3.5
O_2	—	—	0.6	0.6	0.6	0.4	0.5	0.5	0.9	0.4	—	—	—	0.4
CnHm	3.9	7.6	3.0	3.7	3.3	21.0	14.5	15.9	14.0	15.3	6.0	3.9	4.5	2.4
CO	37.6	35.3	8.4	10.6	15.5	1.5	7.2	5.5	11.0	10.0	15.1	21.5	23.0	14.0
H_2	43.4	40.6	52.8	49.4	49.8	19.0	2.5	1.5	2.2	2.7	48.3	47.6	48.0	51.0
$CH_4(+ C_2H_6)$	4.5	7.8	30.6	25.4	22.8	31.6	7.6	8.7	7.4	9.8	14.7	16.8	16.8	22.3
N_2	5.8	4.6	2.6	5.5	4.8	20.7	61.8	61.8	61.5	59.1	6.5	3.1	2.2	6.4
Specific gravity (air = 1)	0.60	0.65	0.38	0.46	0.46	0.81	1.0	1.0	0.94	1.0	0.55	0.51	0.50	0.45
Calorific value (B.Th.U./cu.ft.	400	500	566	548	520	900	450	500	465	500	470	455	500	500

*Figures for the 'Segas' and O.N.I.A.-G.E.G.I. processes are pilot-plant data

processes do, in fact, produce gases of high calorific value and high specific gravity which are too dissimilar from coal-gas to permit their interchangeability. The catalytic processes (in group *c*) produce suitable gases and Table 1 gives typical analyses of the gases obtained in the various processes.

It must also be remembered that in the manufacture of peak-load gas it is important that the plant should be relatively low in capital cost in order to keep the cost of the gas to the minimum.

'BLOW AND RUN' PROCESSES

Pacific Coast process[5]

The development of processes for the manufacture of oil gas took place mainly on the Pacific Coast of the U.S.A. (prior to the introduction of natural gas) where coal and coke were relatively expensive and petroleum was readily available.

Two types of oil-gas plant have been used:[5] (*a*) single-shell and (*b*) two-shell (Jones machine).

In outline the process resembles carburetted-water-gas manufacture in that it involves the use of alternate heating and gas-making periods, but in the oil-gas process the same oil is used in both periods. The gas produced is a mixture of 'blue gas' and oil gas and usually the plant is operated in the U.S.A. to produce a gas of from 550 to 570 B.Th.U./cu.ft.

Jones oil gas plant[5, 7, 8]

In 1928 an improved type of oil-gas process was developed by L. B. Jones and this is usually known as the Jones oil-gas plant.

An advantage of this plant is that the gas is of low specific gravity and is readily interchanged with coal-gas. The process is illustrated diagrammatically in Fig. 1.

Each shell contains two sections of chequer brickwork, one of which constitutes a 'make' chamber while the other acts as a superheater. An oil spray is provided just above the 'make' chamber of each shell. Several operations are involved:

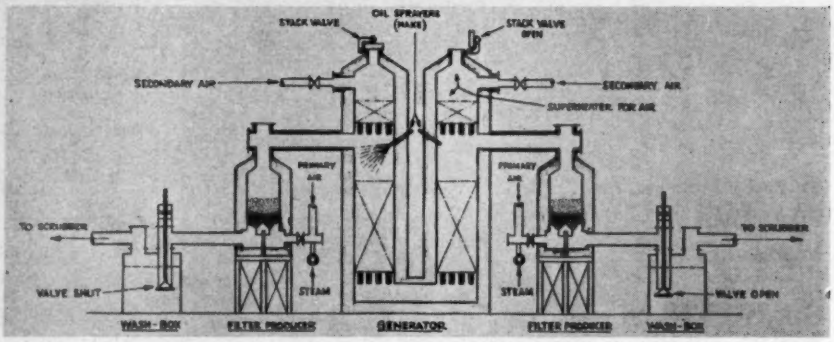
(1) Oil cracking in the presence of 'blue gas' and superheated steam.

(2) Separating lampblack by filtering the gas through a suitable filter bed.

(3) Forming producer gas by blowing the lampblack with air (with or without steam) and this gas is used for heating the plant.

(4) Converting the remaining lampblack into 'blue gas' by steaming after it has been heated by the air blowing. This 'blue gas' and steam constitute the atmosphere in which oil gasification occurs.

Several plants of this type have been operated in the U.K., but have been so modified that lampblack is the primary product, this having a useful market value.[6, 8]



[*H. S. Cheetham, Inst.Pet. and Inst.Fuel*

Fig. 1. Jones oil gas plant. The gas produced is of low specific gravity and is readily interchangeable with coal gas.

Twin-generator process[9, 21]

More recently a process which can operate on oil with up to 6% Conradson carbon has been developed in the U.S.A. Known as the twin-generator process,[9] it produces a gas of high calorific value (about 900 to 1,000 B.Th.U./cu.ft.) and of high specific gravity.

Refractory screen oil-gas process[5, 10]

This process was developed in New York in 1932 and involves the use of a three-shell plant. It is virtually a combination of C.W.G. and Pacific Coast oil-gas processes. The gas obtained is of high calorific value and fairly high specific gravity.

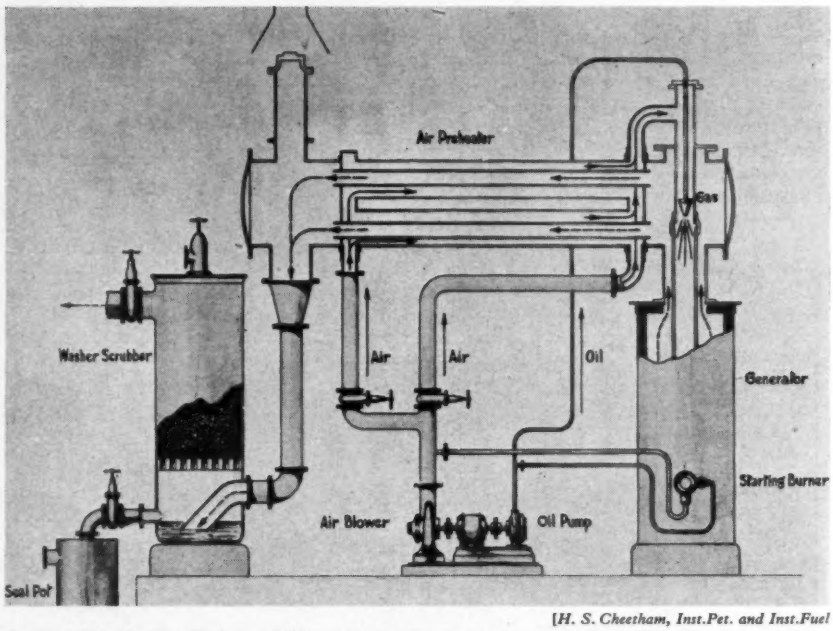
The generator of the plant contains a refractory screen into which steam is admitted with fuel oil. The oil sprayed into the top of the generator is vaporised and the hydrocarbons cracked to a permanent gas on passing through the refractory screen. The steam reacts with the deposited carbon and forms 'blue-gas.' The gases then pass through a carburettor and superheater in which more oil is introduced and cracked. An air blast is used (after steam purging to remove oil gas) in order to maintain the necessary temperatures throughout the plant.

PARTIAL COMBUSTION PROCESSES

This group involves the gasification of *light* mineral oil in either air or a mixture of air and steam by a continuous process. The combustion of a portion of the oil provides the heat necessary for the cracking of the remainder into permanent gases. The nitrogen of the air used is a diluent in the resulting gas and the specific gravity is high.

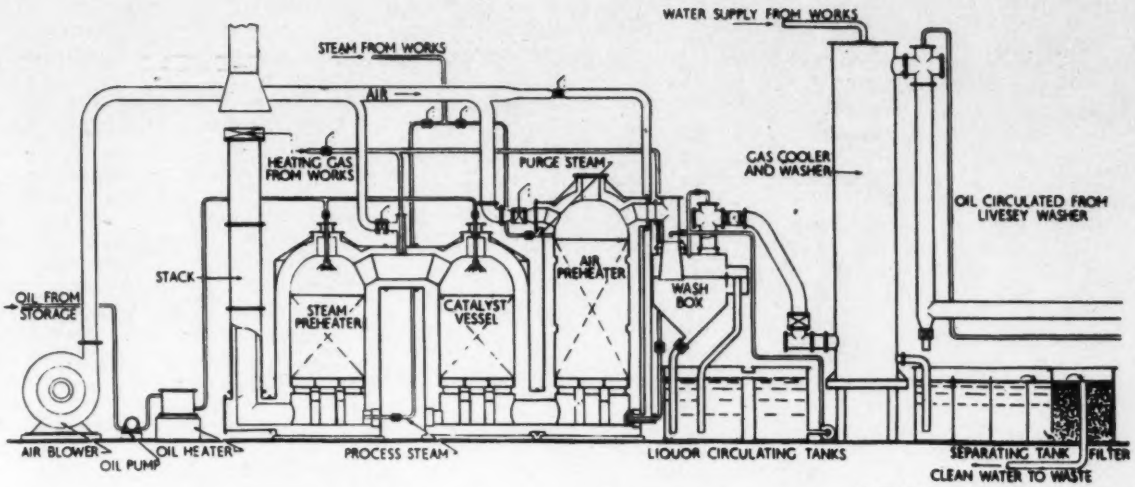
Dayton process[5]

Preheated air and atomised oil are introduced through a feed tube extending from the top nearly to the base of a cylindrical reaction chamber. The gas produced



[*H. S. Cheetham, Inst.Pet. and Inst.Fuel*

Fig. 2. G.E.I.M. installation. This is a French process, rather similar to the Dayton process.



['Fluid Handling' and the S. Eastern Gas Board

Fig. 3. Segas catalytic process. Schematic elevation of the plant installed at Sydenham, London, which works on a 6-min. cycle of operations and produces gas of 500 B.Th.U./cu.ft.

passes through a heat-exchanger so that the entering air is heated to about 370°C. The calorific value of the gas is determined by the ratio of air to oil employed.

G.E.I.M. process[11]

This is a French process rather similar to the one described previously and the layout of the plant is illustrated in Fig. 2.

G.L.C.C. process[12]

In this process air and gas oil in suitable proportions, preheated or not according to requirements, are admitted to a reaction chamber (heated at least to 400°C.) under conditions arranged to give very rapid mixing.

All oxygen in the mixture is consumed and a rather complicated series of oxidation and cracking reactions leads to the destruction of peroxides and aldehydes formed as intermediate products, giving rise to a gas composition similar to that indicated in Table 1.

The gas has a high specific gravity and a low burning velocity and it is unsuitable for distribution except in admixture *in restricted proportions* with normal gas.

CATALYTIC GASIFICATION

The chemical reactions which occur during the cracking of oil are complex and not fully understood, particularly the stages which result in carbon deposition. The train of reasoning in attempting to avoid carbon formation generally seems to have been more or less as follows: since hot carbon reacts with steam and this reaction is known to be catalysed by alkali and alkaline earth bases,[13] then a possible method of controlling carbon formation might be found by using such catalysts to accelerate the reaction of carbon with steam. This seems to have been tried first in the laboratory experiments of M. A. Elliott and W. J. Huff,[14] who used magnesia refractory brick impregnated with 5% of sodium carbonate. They found a pronounced increase in the gasification of the oil carbon and a corresponding decrease in the carbonaceous deposits. There was also an increased thermal yield of gas (of lower calorific value), but there appeared to be no pronounced effects on the pyrolytic reactions. The marked volatility of the alkali of the catalyst was noted. This early work did not seem to lead to any new developments in commercial processes.

The American Gas Association,[15] interested in the possible development of a process for making peak-load gas by the catalytic gasification of higher hydrocarbons in steam, studied nickel: alumina catalysts. It was found, however, that carbon deposition could not be avoided with hydrocarbons higher than propane or butane.

Segas process

An investigation initiated in the laboratories of the former South Metropolitan Gas Co. and described by H. Stanier and J. B. McKean[16] was more successful and showed that carbon deposition could be prevented during the gasification of gas oil in the presence of steam by the use of catalysts based upon alkali or alkaline earth bases. Stanier and McKean have suggested that the function of the catalyst may be to do rather more than promote the steam/carbon reaction and it may also promote direct reaction between gaseous unsaturated hydrocarbons and steam.

A pilot-plant investigation showed that similar results could be obtained with heavy fuel oil and the South Eastern Gas Board, in collaboration with the Power Gas Corporation Ltd., have recently erected a prototype commercial plant of nearly 1 million cu.ft./day gas output at Sydenham.[17] This plant, illustrated in Fig. 3, employs a fixed-catalyst bed and works on a 6-min. cycle of operations producing gas of 500 B.Th.U./cu.ft.

Stanier and McKean also reported a gradual fall in the activity of their early bauxite-sodium carbonate catalysts owing to loss of alkali by volatilisation, and finally a suitable catalyst based upon lime was developed. This catalyst is prepared by moulding and firing at 1,350°C. a mixture of 34 parts of calcium carbonate, 3 parts of bentonite and 63 parts of bauxite and it is mechanically strong.

During the 'make' period, heavy oil is sprayed on to the catalyst bed at about 1,000°C. in the presence of superheated steam coming from the steam preheater. The products pass through the air preheater on their way to the wash box. In the 'blow' period, air under pressure enters the top of the air preheater and from there passes to the catalyst vessel, where carbon (deposited during the make) is burnt off. The waste gases pass to the stack after passing through the steam preheater.

Some carbon deposition does occur when making a gas of 500 B.Th.U./cu.ft. from heavy oil and this necessitates the use of the 'blow and run' cycle, but the amount of carbon is not large.

The composition of the resulting gas will be approximately as indicated in Table 1 (the figures given here actually apply to the pilot-plant experiments). The low specific gravity of the gas is a big advantage and the capital cost of the plant is low, so that the cost of the gas produced should compare favourably with that of base-load coal-gas.

O.N.I.A.-G.E.G.I. process[18]

This process is a development of one devised for the production of ammonia synthesis gas from heavy oil. This preparation of synthesis gas by l'Office National Industriel de l'Azote (O.N.I.A.) has been described briefly in a recent article in this journal.[19]

The above organisation, in collaboration with Humphreys & Glasgow's associated

company in France (G.E.G.I.), have operated a pilot plant for the manufacture of a town gas from heavy oil at Cahors.[20]

A larger plant of about 1 million cu.ft./day capacity is being built at Stafford by Humphreys & Glasgow Ltd. for the West Midlands Gas Board.

The O.N.I.A.-G.E.G.I. plant comprises a refractory-lined combustion chamber, a catalyst vessel and a waste-heat boiler, together with auxiliary plant, and it is automatically operated. The operation is cyclic and comprises two periods, 'conversion' and 'heating.' In the 'conversion' period heavy oil is sprayed on to the catalyst, whilst steam is also admitted from the waste-heat boiler. Some carbon is deposited and this is burned off by preheated air during the 'heating' period in which the catalyst is also restored to a suitable working temperature. The waste gases pass through the waste-heat boiler. The calorific value of the gas can be varied over a considerable range and the gas has a high hydrogen content and low specific gravity which allows it to be used as a town gas without the need for adjustments to appliances.

Acknowledgments

The author is indebted to Mr. G. le B. Diamond, C.B.E., chairman, West Midlands Gas Board, for information concerning the O.N.I.A.-G.E.G.I. process.

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Tower Packings and Packed Tower Design

Data on the design of chemical plant are rarely published. This has meant that, through lack of real knowledge and experience, the proposed units have frequently been over-designed, 'to be on the safe side,' and consequently the equipment for a specific process has been more expensive than was necessary. The first edition of *Tower Packings and Packed Tower Design* took a step towards remedying this lack, setting out to table information which would be of help to the designer and engineers concerned. The second edition* is a great improvement on the first. It is nearly twice as long, contains far more tables and illustrations to help the engineer, and, as many more references have been consulted, it can be taken as generally covering the ground more thoroughly.

In diffusional processes, the most common unit is, perhaps, the packed tower. Fundamentally this is 'a vertical shell placed upon an adequate foundation and filled with so-called packing material,' and accessories such as packing support plates and liquid distributors are very important and can greatly influence the performance of the packed tower, depending on their special characteristics.

As the author says, early methods of packed tower design were more of an art than an applied science, and only comparatively recently have definite methods of design crystallised out of the considerable information now available on packed towers as a whole. A new section illustrates various designs for packed towers and gives suggestions for materials to be used.

Packed towers generally hold specially shaped ceramic bodies, known as tower packings and this book deals with such towers almost exclusively and far more thoroughly than with the question of gas absorption which the author has not attempted to cover fully, although more attention has now been given to liquid-liquid contacting.

The book is divided into roughly two parts, the first dealing with the physical aspects, including flow as such, and the second dealing with design methods, data and performance comparisons.

One of the new forms of packing material is the 'Intalox Saddle' which is described in detail, and then compared with other fillings. The famous Raschig and Lessing rings are described, as well as the Berl Saddle and various spiral rings. Grid and catalytic packings as well as newer ideas, *i.e.* metal, wiremesh, etc., are touched on and redistributors and support plates are dealt with too.

As the book was commissioned by a firm specialising in the manufacture of ceramics, it is understandable that emphasis is laid on tower packings made of clay bodies, although metal packings are covered more adequately in this edition. In Britain, the use of contact rings of metal, notably mild steel and stainless steel, has assumed about equal importance with the ceramic.

One error has not been corrected. The size of ceramic Lessing rings is stated on p. 9 as being limited to a range between 1 and 2 in. In fact, they are used in a much larger variety of sizes, from $\frac{1}{8}$ to 8 in.

The mechanics of tower operation have been dealt with far more thoroughly in this new edition, and the greater use of illustrative problems, complete with solutions, should prove of value. Another useful feature is the incorporation of a glossary, explaining the technical terms in simple language.

This is an excellent book for the chemical engineer, and the publishers, the U.S. Stoneware Co., should be congratulated on such a very good contribution to our knowledge of the design and calculation of chemical apparatus. FELIX SINGER

**Tower Packings and Packed Tower Design*, by Max Leva. Published by United States Stoneware Co., Akron, Ohio (2nd edition, Dec. 1953), pp. 204 + 8.

Recent publications

Straining fluids. A new 8-pp. illustrated pamphlet on the *Rotoklene* self-cleaning strainer, comes from Ashworth & Parker Ltd. In addition to its more usual applications in lubricating systems for engines, gear units, etc., oil-burning equipment and water straining, this equipment can be used for many other liquids or semi-liquids difficult to strain.

Soldering and brazing. Information on the soft soldering of aluminium, soft soldering in general, the uses of *Amalgam* fusible alloys and bearing metals, and silver soldering and brazing, is included in five pamphlets issued by Grey & Marten Ltd. Leaflets containing details of the compositions and melting ranges of B.S. brazing solders and soft solders are also issued.

Pulverising and lime conditioning. Publication G532 issued by International Combustion Ltd. (12 pp.) describes and illustrates the Raymond automatic pulveriser—used in the production of finely powdered materials such as hydrated lime and chemical hydrate, clays and kaolins, litharge, lead arsenates, dry colours, borax, dyestuffs, filter cake, ball clay, calcium phosphate, starch, etc.—and the Raymond lime conditioner, which operates under a partial vaccum and is claimed to be dustless in operation. Another pamphlet deals with the Raymond screen pulveriser.

Peat as a Fuel and a Source of Chemicals

REPORT OF THE SCOTTISH PEAT COMMITTEE

Peat has attractive possibilities not only as a domestic and industrial fuel but also as a source of chemicals. However, before these possibilities can become realities there are many technical snags to overcome, both in the production of peat in a usable form and in processing it. In Scotland, where workable peat deposits are estimated at 600 million tons of solids—equivalent to 20 years' output of coal in that country—a Scottish Peat Committee was set up in 1949 to investigate the possibility of developing these deposits. The report of the Committee, published recently, is an excellent survey of the production and utilisation of peat and throws fresh light on the technological and economic problems involved. Here are extracts from the report dealing with the dewatering of peat and its utilisation as a fuel and as a source of wax and chemicals.*

FOR the past 50 years some of the best scientific and engineering brains in many countries have been trying to arrive at an efficient and economical way of producing and utilising peat. On the production side, the most baffling problem is finding a practicable means of dewatering the raw peat. On the utilisation question, interest centres chiefly on the use of peat as a fuel for power generation and other industrial operations, but there are also hopes of extracting chemicals from peat. In Sweden, a State authority is giving particular attention to this possibility. In this article, the possibility of using peat as a raw material for the extraction of montan wax, for carbonisation, for the Fischer-Tropsch process and for hydrogenation are briefly discussed. Another use for peat other than as a fuel is in the purification of coal gas.

In the development of peat as a fuel, different countries have achieved varying measures of success. It is reported that in Russia, for instance, some 30% of the power stations operating in 1934 were burning peat fuel, and peat-fired power generating capacity is being increased nearly fourfold under the second five-year plan. In the Irish Republic, where something like 5 million tons p.a. of peat are produced, two peat-fired power stations are in operation. In Germany, peat has been used as a fuel for mobile gas producers. In Denmark, production of peat for fuel was greatly accelerated by a scarcity of other fuels during the war, and one or two engineering firms have made a speciality of peat-winning and -drying equipment. In Canada, the use of peat for generating electricity has recently been investigated by the Hydro-Electric Power Commission of Ontario. The U.S.A., too, has been studying peat development.

The main projects with which the Scottish Peat Committee has been concerned are a survey of the Scottish peat deposits; investigation of methods of winning, handling and removing water from peat; and research into burning peat in both open- and closed-cycle gas turbines. In addition, however, a number of other possible uses for peat are discussed in the report. The following matter is based on those parts of the report which deal with the dewatering problem and the industrial utilisation of peat.

*Report of the Scottish Peat Committee, illustrated, H.M.S.O., Edinburgh, 1954, 5s. net.

DEWATERING PROBLEM

The problem which has baffled all peat investigators for many years is that of finding an efficient and economical means of reducing the moisture content of peat from upwards of 90% in the raw state to a level at which it can be burned. Nearly all processes now operating commercially rely on natural forces of wind and sun to do so. This makes peat production a seasonal operation lasting only about a hundred days in the year and consequently expensive and inconvenient. Moreover, output of peat is liable to wide fluctuations from year to year according to the weather.

Many attempts have been made to find methods of artificial removal of water from peat, but so far with little commercial success. Practically all methods attempted have sought to remove water by applying heat or pressure to the raw peat. These methods have so far proved difficult because:

(1) In thermal processes the heat must be provided by burning fuel, either peat or something else; and so much fuel has to be burnt to dry raw peat, that the net gain of fuel at the end is either very little, or non-existent.

(2) If pressure is tried the colloids in the peat resist all pressure and, while a certain amount of water can be pressed out of the sponge-like fibres, the major part remains. Experiments have shown that, by freezing the peat first, the colloids can be broken up, but there is no evidence yet that this would be a commercial proposition.

The advent of the gas turbine introduces a new factor in that the heat readily available to dry peat is greater than in the traditional types of steam generating plant, and there was thus reason to hope that previous results might be improved upon.

Mechanical dewatering process

Only one process which has so far worked on a commercial scale seemed likely to give early results. This is the Madruck process, developed in Germany, for removing water from peat by mechanical pressure. The principle of the process is that raw peat excavated from the bog is mixed with dried peat dust containing approximately the same quantity of solid matter, and the mixture is then subjected to pressure for about 1 min. The process does not produce peat fit for combustion; indeed, the limit to which it has so far proved practicable to reduce the moisture content of the raw peat is about 70% and very often higher. The process must, therefore, be supplemented by thermal drying to produce not only the peat needed for combustion but also dry peat mix-back for the press. Hitherto, the consumption of heat in this second-stage drying has limited the economic success of this process. It is, however, in operation in Germany at the Wurtemberg State peat works at Schussenreid, and development of a new type of press is taking place at the original Madruck works at Staltach, Bavaria. The Scottish Peat Committee arranged a full-scale trial at Schussenreid.

The results of this trial were disappointing and it was decided that, although basically the design of the press was sound, it had not reached such a stage of efficiency in relation to its cost as to justify its commercial use in Scotland.

The Ministry of Fuel and Power arranged for the manufacture of two presses: a small model, the Langdale press, with an input of 3 tons/hr. of raw peat; and the Shaw press, with an input of 12 tons/hr.

Langdale press

This press is of conventional dehydration type having a downstroking piston and

a 3-ft.-diam. cylindrical peat chamber, the axis being vertical. It is of fabricated construction and controlled manually.

The objects of the Langdale press are:

(*a*) To allow full-scale development of Madruck dewatering process for use with Scottish peat to be commenced at an early date.

(*b*) To provide press cake in an adequate quantity for at least the preliminary testing of a Ruston & Hornsby 750-kw. gas turbine.

(*c*) To act as a standby during development of the Shaw press.

Shaw press

This introduces novel features, having two peat chambers separated by a floating piston and pressed by a single hydraulic ram set with its axis horizontal. The filter faces, each 3 ft. × 4 ft., are all vertical, which facilitates the flow of water from them. The floating piston separating the two chambers moves freely under the difference in pressure between its faces during the compression stroke and is withdrawn by the main piston on the return stroke; this is accomplished simply by side rods attached to the floating piston which have collars that take up on a lug on the main piston. The trunnions by which the side rods are attached to the floating piston move along slots in the side walls during the stroke. Similarly the water egress hole in the base of the floating piston moves opposite a slot in the floor. The press will be supplied complete for automatic action.

The objects of the Shaw press are:

(*a*) To verify the practicability of a two-chamber layout for a high output/cost ratio and for effective dewatering.

(*b*) To allow an accurate assessment of the cost of the dewatering process under full-scale operation in Scotland.

(*c*) To provide press cake in a quantity sufficient for continuous running of the 750-kw. gas turbine at full load, in conjunction with that engine's exhaust flash drier.

Other processes investigated by the committee included wet carbonising, dewatering by centrifuge, and electro-osmosis. These processes are, at present, less promising than the pressure dewatering process. The Department of Agriculture for Scotland carried out experiments at Gardrum Moss to see how far the moisture content of raw peat could be reduced by excavating and heaping it in the moss. The pumping of raw peat, as a means of transport from the moss, is also being investigated.

USES OF PEAT

Gas turbines

Very satisfactory progress has been made with both open- and closed-cycle types of peat-fired gas turbine, and the committee point out that, if the work done in the past three years is to have practical result, it is essential to proceed to a semi-experimental, semi-commercial plant working on a bog. It is estimated that a small peat-burning closed-cycle gas turbine of 2,000 kw. might produce power at a cost comparable with small diesel stations of similar output, but the cost would be much higher than that of power produced from large hydroelectric schemes. On the other hand, once a large peat-fired plant can be developed, the committee add, important economies could result and there are reasonable grounds for thinking that such a plant could produce power at a cost comparable with large coal-fired steam stations.

Peat as an industrial and domestic fuel

Apart from use as fuel for generating electric power, the most common use of peat is, of course, as solid fuel for houses, hotels and industrial institutions. It can be used either in the form of sod peat produced mechanically or by hand, or as briquettes produced by the milled peat process and subsequent thermal drying as in Ireland, Normandy, Denmark and Sweden or by pressure dewatering and thermal drying as in Germany. The production of sod peat is not at present commercially attractive in Scotland.

Briquettes are at present more expensive to produce than sod peat (the cost in Ireland in 1950-51 was £3 5s. per ton), but their calorific value is considerably higher and their bulk much less (only 20% greater than coal). It is very doubtful if a plant set up solely for the production of peat briquettes could in Scotland produce at prices competitive with coal, though, in view of the extreme shortage of coal, peat briquettes, even at a higher cost, may well find a good market for many years. A crucial factor is likely to be transport costs.

The best method of producing briquettes is probably in association with an electric power plant. It may well be that at dry periods of the year a surplus of material can be dried and made available for briquetting, thus constituting a by-product of the power plant. Indeed, depending on economic circumstances, it may well become worth while deliberately to switch a considerable proportion of the output to briquettes.

Wax extraction

Before the war, Great Britain imported up to 1,000 tons p.a. of crude montan wax, mainly from Germany. The wax is used in a variety of products, including polishes, wax compositions (for carbon paper, dentistry, gramophone records, etc.), greases and soaps. During the war, when German supplies ceased, experiments were carried out at the Fuel Research Station on the extraction of wax from British lignite and peat. The ester wax in peat, which is somewhat similar in properties to the montan wax obtained from German brown coal, can be extracted by means of a solvent such as benzole or a mixture of benzole and alcohol.

The yield of ester wax extractable by means of benzole varies from 3 to 17% on the dry peat, in different peat deposits, and there should be no difficulty in choosing a suitably situated bog which would give a continuing source of supply of peat yielding about 10% of wax.

Immediately after the war the extraction of waxes from peat seemed a most attractive possibility, since imported ester waxes were costing about £370 a ton. Moreover, if peat waxes could be substituted for carnauba and candelilla waxes, there would be a considerable saving in dollars. It must be pointed out, however, that peat wax is in certain respects an inferior material to montan wax. The most important ways in which peat wax differs from montan wax are in possessing a lower melting point (by about 10 to 15°C.) and a higher content of resinous and asphaltic substances. Another important property from the point of view of the wax user is the miscibility of the wax with paraffin wax. Crude montan wax is completely miscible, but crude peat wax, owing to its higher asphalt content, is not. A separation of the asphalt from peat wax may be achieved by solvent treatment, and the treated wax is then also miscible with paraffin wax. Other possible methods of refining peat wax also merit attention.

The project is not economically attractive at present, but it is another possibility which should be kept in mind for association with any large-scale schemes for fuel and power purposes which may later be developed.

Peat in coal gas purification

The bulk of the coal gas manufactured in Scotland is purified from sulphur by passage through bog iron ore obtained mainly from Holland. When supplies of bog iron ore were cut off during the war and indigenous material was found deficient in quantity, the development of substitutes was stimulated. At Edinburgh gas works a substitute bog iron ore was developed incorporating peat. This substitute is known by the name *Granox* and it consists of 15.5% peat tailings (30% moisture), 43.5% iron oxide (20% moisture), 3.5% soda ash and 37.5% added water. Its density is 0.58. The iron oxide is burnt spent oxide obtained from a local sulphuric acid works and it is activated by the presence of the soda ash. When the *Granox* is spent in gas purification, that is to say charged with about 40% sulphur and no longer active, it is returned to the sulphuric acid works, where the sulphur is burnt out of it for the manufacture of sulphuric acid, leaving once more a residue of burnt spent oxide, which is returned to the gas works to make further *Granox*.

Natural bog ore has only recently again become available to the Edinburgh gas works and the relative virtues of this and

of *Granox* will require to be confirmed in the light of further experience. The indications up to the present are that a mixture of equal quantities of good-quality natural bog ore and *Granox* has superior qualities to either when used alone. The tendency of the *Granox* mixture is to dry out and become excessively hard, which sets up undesirable back pressure in the gas purification plant. On the other hand, the natural ores are hydroscopic and pick up moisture, becoming very wet with the same result of excessive back pressure. A mixture of the two substances modifies the undesirable properties of both and the resultant material remains in a suitable physical condition, maintaining its activity without setting up high back pressure.

Until this latest experiment the Edinburgh gas works had been employing in the main a mixture of one-third *Granox* and two-thirds proprietary synthetic iron oxide mixture. The proprietary mixture functions satisfactorily alone, but is more expensive. It has been found that a 33⅓% inclusion of *Granox* has no adverse effect upon the properties of the proprietary material and reduces costs.

If the use of *Granox* in the way described above could be developed at gas undertakings generally, it would be a useful though minor outlet for peat. Again, however, it would seem that the peat would have to be produced in plants operated primarily for other purposes.

Carbonisation of peat

About 50 million tons of coal mined in Great Britain is carbonised for the production of coke and gas as main products, about 2 million tons of tar being obtained as a valuable by-product. When considering the possibility of winning peat for use as a fuel, it is therefore natural to ask whether peat could not be carbonised.

The raw material for such work as has been done on peat carbonisation has been air-dried peat containing 25 to 30% moisture. The carbonisation of this material yields coke or char (about 25 to 30%), tar (about 5 to 10%), gas (about 15 to 40%) and aqueous liquor (about 30 to 50%), depending on whether carbonisation is effected at low or high temperatures.

Peat coke. Peat coke is high in carbon content (85 to 90%), low in sulphur, phosphorus and ash and is highly reactive to oxygen and steam. It might have some particular use in certain industries in which a fuel of this type would be necessary. For instance, it has been claimed that peat coke would be suitable for certain metallurgical purposes owing to its low contents of sulphur and phosphorus and also for the reduction of zinc ores and for the manufacture of carbon disulphide.

During World War 2, peat coke, it is understood, was utilised to some appreciable extent in European countries as a fuel in mobile gas producers, but it does not appear that this use will have any peacetime application in this country.

Gas. The yield of gas per ton of air-dried peat varies from 5,000 to 15,000 cu. ft. with thermal yields of 15 to 50% depending on whether carbonisation is effected at low temperature (600°C.) or high temperature (1,000°C.). By either method of carbonisation the gas is of low calorific value, about 350 B.Th.U./cu.ft. The gas produced at low temperature contains about 50% of carbon dioxide with an appreciably lower content of about 20% in gas produced at high temperature. The calorific value of the gas could be increased by the removal of carbon dioxide by water washing under pressure.

Tar. The yield of tar varies considerably with the type of peat and the temperature of carbonisation. For the best-quality peat the yield would be about 20 to 25 gal./ton by low-temperature carbonisation, falling to about 10 to 15 gal./ton in high-temperature carbonisation. Peat tar is a black viscous liquid with an unpleasant odour and much less is known of its composition than that of coal tar. On distillation, peat tar gives 70 to 80% of oils, leaving a residue of 20 to 30% of pitch. The oils contain bases (about 5%), hydrocarbon oils (50 to 60%), paraffin wax (5 to 15%) and acidic material (up to 30%). The acidic material, which in coal tar consists almost entirely of phenols, in peat tar comprises phenols, fatty acids and hydroxyacids in proportions which vary according to the temperature of carbonisation. If the carbonisation of peat should be undertaken, the composition, treatment and utilisation of peat tar would require further study.

Liquor. The liquor produced contains ammonia, methyl alcohol, acetone, acetic acid and tar acids, but the yields of these products are relatively small, and the cost of recovery from a large volume of liquor would not be economical. The production of such large quantities of liquor containing these products would be an embarrassment on account of the difficulty of disposal.

The major problem in the carbonisation of peat is the high water content of the material. Its yield of useful products is, moreover, much less than that of coal and, as long as coal is available for the carbonisation industries, it will be preferred to peat, unless and until further research should discover peculiar properties in products derived from peat and uses for these products, *e.g.* in plastic materials. Pending such discoveries, even if there is a shortage of coal, there are other directions than carbonisation in which peat can more suitably be substituted for coal. The committee have therefore concluded that carbonisation cannot at present be regarded as hopeful.

Peat as a raw material for the Fischer-Tropsch process

The cost of the Fischer-Tropsch process depends mainly on the cost of the synthesis gas and hence of the raw material. At prevailing prices of coal and coke the process is not commercially attractive in the United Kingdom. Peat could be used as a source of synthesis gas by carbonisation and gasification of the resultant coke, but in this case some 16 tons of air-dried peat would be required to produce 1 ton of Fischer-Tropsch oil.

In Germany peat has been converted directly into synthesis gas in a Pintsch-Hillebrand generator, and other processes for the complete gasification of solid fuels could doubtless be adapted for use with peat. Using such processes, between 8 and 9 tons of air-dried peat would be required to produce 1 ton of synthesis oil.

For peat to become attractive as a raw material for this process it would be necessary to find means of producing air-dried peat at less than 60% of the present price of average-quality coal and to establish the most suitable process for the direct gasification of peat.

Hydrogenation of peat

The production of motor and aviation spirits from peat by hydrogenation has been considered.

In general, the ease of hydrogenation of coals increases and the yield of oil decreases with decrease in carbon content. For hydrogenation at a pressure of 250 atm., the most generally suitable bituminous coals are those having a carbon content of 80 to 85% (dry, ash-free basis). While therefore it would be expected that oil could be made from peat by hydrogenation, the yield of oil would be very low because of the low carbon content of the peat and because of the loss of carbon as oxides and hydrocarbons during the hydrogenation treatment; furthermore, the high oxygen content of peat would involve a large consumption of hydrogen in the elimination of oxygen as water. The committee therefore conclude that peat cannot be regarded as suitable raw material for hydrogenation.

Other possible uses

Raw milled peat may be used industrially in plants such as filter beds, sewage beds and where the preliminary coarse purification can be carried out by absorption.

The examination of any metallic residues in the ash of peat or the utilisation of the peat substance as an ion-exchange material as used in water-softening plants may lead to useful applications.

Synthetic Fats

(*Concluded from page* 168)

is necessary. Table 1 shows the major operations in each case.

Although, as Table 1 indicates, the conversion of waxes involves far more costly processing, the additional cost is far less than the difference in cost in the base materials.

In his next article, Mr. Seaman will discuss materials and processes.

FUEL ECONOMY in the Chemical Industry

2. Utilisation of Services

By R. Walker, A.M.I.Chem.E., M.I.Mar.E., A.M.I.Plant.E.

In the first part of his article, published in our May issue, the author considered the £ s. d. of fuel efficiency. Here he discusses the design and utilisation of services—boilers, steam utilisation, power generation, gas turbines and heat pumps.

BOILERS

Efficiency of existing plants

A BOILER plant must be instrumented if it is to work efficiently. One of the biggest difficulties when estimating the efficiency of a boiler is to measure the evaporation under steady conditions. Steam metering is not accurate unless a steam calorimeter is used to measure the dryness. If the steam is superheated then the temperature must be measured, and in either case the results must be corrected accordingly. So-called dry saturated steam is never just dry saturated, it is invariably wet.

Water measurement by weight is the best arrangement but is not easy to install, particularly if a common feed system supplies a number of boilers. Piston-type water meters are fairly good if the flow is not pulsating. It is necessary, of course, to meter at feed pump pressure, and a by-pass valve should always be fitted where positive displacement meters are installed. If the feed water is measured or weighed, allowance should be made when drawing up the heat balance for the continuous blow-down, steam jets to fire bars, etc., if applicable.

Coal must be weighed and corrected for moisture. The calorific value should be estimated from several samples, and an average result recorded.

Every boiler should be fitted with a CO_2 recorder. The conductivity type are the best, but will give a high reading if H_2 is present. Usually, however, if hydrogen is present there will be smoke from the stack and conditions of insufficient air will prevail. The CO_2 meter should, of course, be periodically checked with an Orsat. apparatus.

An alternative means of estimating the excess air is the air-stream meter which is superseding the CO_2 meters in the U.S.A. and is now available in this country.

Excess air

This is probably the worst offender in the boiler house and causes loss of efficiency in two ways as follows:

(*a*) Increases the weight of flue gas and hence the heat loss in the chimney.

(*b*) Causes higher flue gas temperatures due to low heat transmission in the radiation zone, resulting from the cooling effect in the high temperature zone.

Table 1. Effect of Excess Air[1]

CO_2	*Excess air*	*Thermal efficiency*
%	%	%
14	35	68
11	70	61
8	135	48

Efficiency reduced from 68% to 48% corresponds to an increase of fuel consumption of 27%.

Mechanical stokers

A mechanical stoker will greatly reduce the amount of excess air and will improve the efficiency by 10% to 15%. The choice of the type of stoker will depend on the furnace and the quality and rank of coal available.

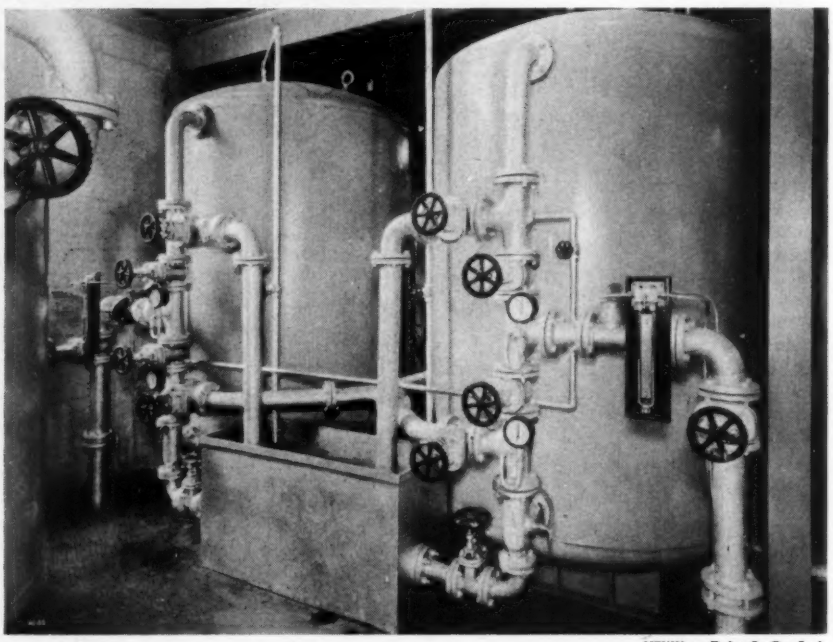
STEAM UTILISATION

From the Ministry of Fuel and Power mobile testing unit surveys, it is estimated that for every 1% saved at the boiler house, 4% can be saved on distribution and process usage.

Steam should be supplied dry. It is better to have a small amount of initial superheat at the boiler house and lose this on distribution rather than lose latent heat. Cast iron must not be used with superheated steam above 400°F.

The proportion of latent heat to total heat is greater in low-pressure steam than in high-pressure steam. On the other hand, the lower the pressure the bigger the pipes to carry the same weight of steam. If power is generated with back-pressure plant, then obviously the lowest practical pressure should be used.

There is no need to mention here the importance of lagging. Good lagging should be about 97% efficient. When



[*William Boby & Co. Ltd.*

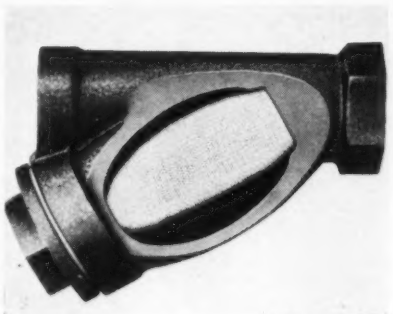
Base exchange plant for water treatment, typical of that installed in chemical works.

determining the optimum thickness of lagging it is usual to assume the life of lagging on undisturbed pipes to be between five and seven years and very often it is much longer. Lagging in exposed places deteriorates even though it may at first sight appear sound. The outer surface must be impervious to water.

Very hot surfaces such as certain parts of furnaces and combustion chamber casings of Cochran vertical boilers should never be lagged or the brickwork temperatures may become dangerously hot with resulting high maintenance and down time.

Steam trapping

More steam is wasted by wrong use of steam traps than with any other single item of equipment. Usually little attention is given to their specification or their maintenance. They either leak when they are supposed to be shut off or do not open at all. By-passes are frequently left open with the consequent reduction in pressure and temperature in the vessel, plus an enormous wastage of steam. Each trap should be carefully specified, *i.e.* steam inlet and condensate discharge pressure, this will determine the size of the orifice in relation to the size of the float. Where bucket traps are concerned it is better to install a size larger than specified by the makers, in order to reduce the frequency of discharge and consequently of maintenance.

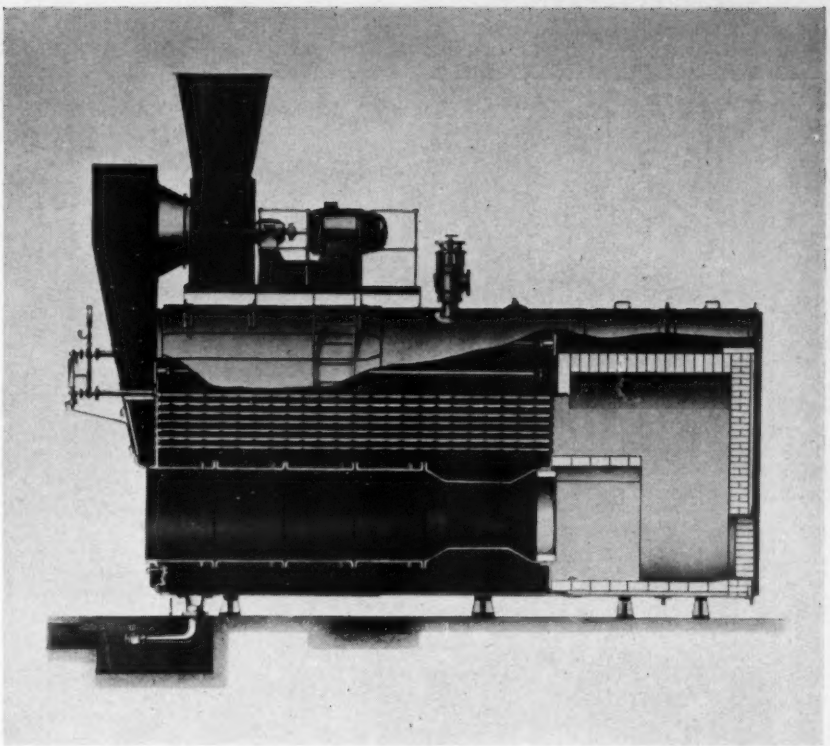


[*Spirax-Sarco Ltd.*

A pipe strainer in front of a steam trap prevents scale or jointing material from stopping the proper seating of the trap valve and allowing steam to blow, or blocking the valve seat and causing a hold up.

There are many types of steam traps available on the market and each have their decided advantages for the application for which they were developed. There is also a comprehensive amount of literature published on the selection and correct method of installing steam traps, and one manufacturer even runs a correspondence course on steam trapping.

Trap by-pass valves are the most wasteful valves on the plant. They should never discharge into the condensate return main because it is impossible to tell if they have been left open or are letting by. There appears a good opening for someone with an inventive mind to develop a device which when installed in the trap by-pass line will enable water to pass through but will produce a nerve-shattering scream when steam blows through.



[*Cochran & Co., Annan, Ltd.*

The 'Sinuflo' economic boiler is of the horizontal, multitubular, dry-back type and the standard design works with induced draught generated by a fan; as shown, both fan and prime mover are mounted on a platform attached to the top of the boiler shell. The unit is self-contained and requires no brick setting. The tubes undulate in the horizontal plane so that the gases passing through are made to impinge upon the surfaces of the tubes. Evaporative capacities of these boilers range from 6,000 to 30,000 p.s.i. from and at 212° F. and standard sizes are from 6½ ft. to 13 ft.

Condensate return

As much condensate as possible should be returned to the boiler house. To produce demineralised water with a water treatment plant capable of reducing the silica content to 1.0 p.p.m. will cost 2s. 6d. per 1,000 gal.

Condensate should be collected into condensate collection tanks at suitable locations near to the 'centre of gravity' of the steam-consuming process plants, and the water suitably treated.

Cold condensate is distilled water and will readily pick up CO_2 and O_2. This is frequently in evidence by the deep grooving in many condensate return lines. The *p*H should be corrected to about 8.5 and the O_2 absorbed with Na_2SO_3 (sodium sulphite). The collection tanks have a further advantage in that a source of condensate contamination can be more readily traced and isolated from the tank.

There is, however, always a danger of the return feed water being contaminated with the product. One well-known boiler manufacturer has stated that they have found coffee, sugar and all manner of products in industrial boilers. Where a large number of products are made in one factory it is not always an easy matter to install reliable alarm systems in feed water lines to detect contamination. The damage that can result due to contamination can be considerable, and may easily outweigh any saving gained. Perhaps the safest system is one involving three large tanks located near the boiler house. They are suitably interconnected in order that one tank can be supplying water to the boilers whilst the second tank is receiving returned condensate from the works and the third tank is being sampled and tested for contamination.

The water should then be finally treated and deaerated before passing to the feed pumps. Care must be taken with the chemical dosing in the feed tanks, otherwise precipitates may deposit in the feed lines. In certain cases it is better to adjust *p*H only in the feed tanks and inject the phosphate compounds under pressure into the boiler direct. A water treatment plant has a further advantage of reducing the total solids in the boiler, thus eliminating or reducing the thermal losses resulting from continuous blow-down.

Heat from effluents

Quite a number of cases arise where heat can be reclaimed from effluent liquids and

Table 2. Heat Loss from Lagged Pipe to Still Air at 68°F.

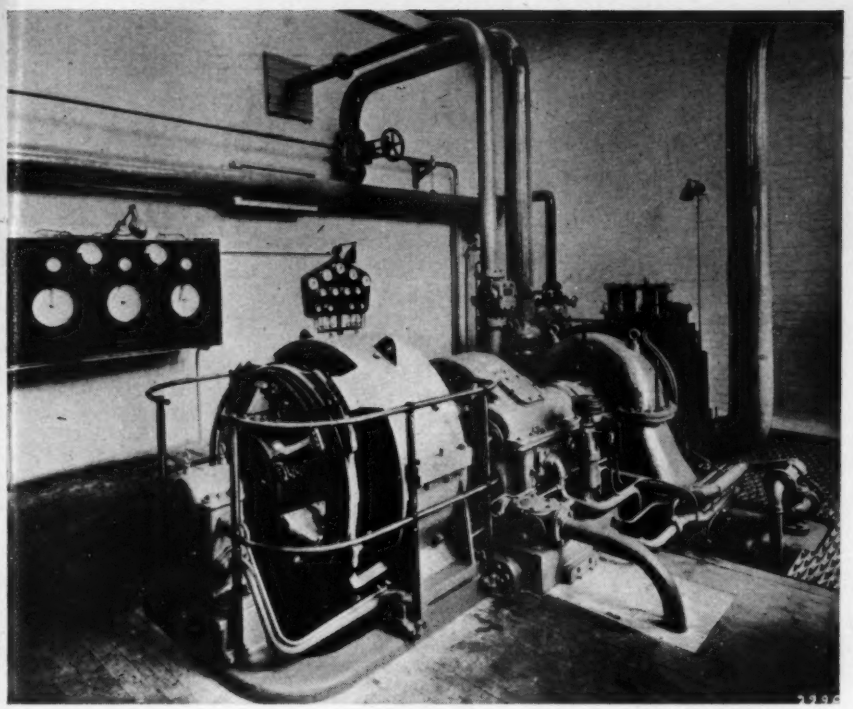
For outdoors, increase the following heat losses by 15%*

Temp. of pipe. Conductivity.			180°F. 0.38			200°F. 0.38			300°F. 0.40			400°F. 0.43			500°F. 0.45			600°F. 0.47			700°F. 0.50			800°F. 0.53			900°F. 0.57			1000°F. 0.61		
Bore of pipe	O.D. of pipe	Thickness of insulation	Heat loss, B.Th.U./ft. run/hr.	Efficiency, %	Surface temp., °F.	Heat loss, B.Th.U./ft. run/hr.	Efficiency, %	Surface temp., °F.	Heat loss, B.Th.U./ft. run/hr.	Efficiency, %	Surface temp., °F.	Heat loss, B.Th.U./ft. run/hr.	Efficiency, %	Surface temp., °F.	Heat loss, B.Th.U./ft. run/hr.	Efficiency, %	Surface temp., °F.	Heat loss, B.Th.U./ft. run/hr.	Efficiency, %	Surface temp., °F.	Heat loss, B.Th.U./ft. run/hr.	Efficiency, %	Surface temp., °F.	Heat loss, B.Th.U./ft. run/hr.	Efficiency, %	Surface temp., °F.	Heat loss, B.Th.U./ft. run/hr.	Efficiency, %	Surface temp., °F.	Heat loss, B.Th.U./ft. run/hr.	Efficiency, %	Surface temp., °F.
in.	in.	in.																														
¼	⅝	1	16.25	75.1	80	19.2	77.3	82	35.2	80.0	94	53.6	81.9	108	72.8	83.8	123	93.5	85.5	140	117.	86.7	156	142.5	87.8	175	172	88.7	197	202	89.6	221
		1½	13.63	79.1	75	16.1	81.0	77	29.5	83.3	84	45.3	84.7	93	61.5	86.3	102	79.0	87.7	112	99.3	88.7	123	121.3	89.6	135	147	90.4	150	175	91.1	165
		2	12.10	81.5	73	14.3	82.3	74	26.2	85.1	79	40.2	86.4	85	54.75	87.8	92	70.5	89.0	98	88.5	89.9	107	108.0	90.7	116	131	91.4	126	157	92.0	137
½	1¼	1	18.6	76.7	81	21.9	79.0	83	40.3	81.5	96	61.5	83.3	110	83.5	84.9	126	107	86.5	142	123.5	87.7	160	162	88.8	180	196	89.7	204	233	90.5	229
		1½	15.4	80.7	76	18.2	82.6	78	33.4	84.7	86	51.0	86.1	95	69.5	87.4	104	89	88.7	114	112	89.7	126	136	90.6	139	166	91.3	154	197	92.0	171
		2	13.5	83.1	74	15.9	84.7	75	29.2	86.5	91	45.0	87.8	87	61.0	88.9	95	79	90.4	101	99	90.9	109	121	91.6	118	147	92.3	129	175	92.8	141
1	1½	1	21.4	78.1	82	25.3	80.0	84	46.5	82.7	98	71.0	84.3	113	96.0	85.9	129	123	87.4	146	153	88.6	165	187	89.6	186	226	90.5	211	267	91.2	237
		1½	17.5	82.1	77	20.7	83.6	78	38.0	85.9	87	58.4	87.1	96	79.0	88.4	107	101	89.6	117	127	90.5	130	155	91.4	143	188	92.0	160	224	92.7	177
		2	15.3	84.4	74	18.0	85.8	75	33.4	87.7	81	51.0	88.8	88	69.0	89.8	96	89	90.9	103	112	91.7	112	136	92.4	122	166	93.0	140	197	93.5	147
1¼	1⅝	1	27.	79.7	83	32	81.5	85	58	84.0	100	89	85.6	116	120	87.1	133	154	88.5	152	193	89.6	173	234	90.6	195	283	91.5	221	335	92.2	249
		1½	21.7	83.8	77	25.5	85.2	79	47	87.1	88	72	88.4	99	97.5	89.6	110	125	90.7	122	156	91.6	136	191	92.4	151	232	93.0	168	275	93.6	187
		2	18.5	86.1	75	22.0	87.3	76	40	89.0	83	62	90.0	90	84.0	91.0	98	107	92.0	107	135	92.7	117	165	93.4	128	200	94.0	140	240	94.4	154
		2½	16.5	87.6	75	19.5	88.7	74	36	90.1	79	55	91.1	85	75.0	92.0	91	96.5	92.8	97	122	93.5	105	149	94.1	113	180	94.6	123	215	95.0	134
		3	15.1	88.7	72	17.8	89.7	73	33	91.0	77	50	91.8	82	68.5	92.7	86	88.0	93.5	92	110	94.0	98	136	94.6	104	165	95.0	112	198	95.4	131
2	2⅜	1	31.5	80.6	83	37	82.2	86	68	84.6	101	103	86.2	118	140	87.7	136	178	89.1	155	224	90.2	177	272	91.2	200	327	91.9	227	388	92.6	256
		1½	24.8	84.7	78	29	85.9	80	54	87.8	89	82.5	89.0	101	111	90.2	112	142	91.3	124	180	92.1	139	219	92.9	154	264	93.5	173	315	94.0	192
		2	21.0	87.0	75	25	88.0	76	45.8	89.6	83	70.0	90.7	91	95	91.6	100	122	92.6	109	154	93.3	119	187	93.9	131	227	94.4	144	272	94.8	158
		2½	18.7	88.5	73	22	89.4	74	40.5	90.8	80	62.0	91.7	86	84	92.6	92	108	93.4	99	136	94.0	107	166	94.6	116	203	95.0	127	242	95.4	138
		3	17.0	89.5	72	20	90.3	73	37.0	91.6	77	56.6	92.5	82	77	93.2	87	98.5	94.0	93	124	94.5	99	152	95.0	107	185	95.4	115	221	95.8	124
3	3½	1	42.0	81.5	84	49.5	83.0	87	91.0	85.5	103	138.0	87.0	121	187.0	88.5	140	239	89.9	160	298	90.9	183	363	91.8	208	438	92.6	237	517	93.2	267
		1½	32.5	85.7	79	38.2	86.9	81	71.0	88.7	91	108.0	89.9	103	146.0	91.0	116	186.5	92.1	129	234	92.9	145	286	93.6	162	346	94.1	181	410	94.6	203
		2	27.2	88.0	76	32.0	89.0	77	60.0	90.6	85	90.0	91.5	94	122.5	92.5	103	157.5	93.3	112	198	94.0	124	242	94.6	137	293	95.0	151	350	95.4	167
		2½	23.8	89.6	74	28.0	90.4	75	51.5	91.8	81	79.0	92.6	88	107.0	93.4	95	138.0	94.2	102	174	94.7	111	212	95.2	121	258	95.6	132	307	96.0	145
		3	21.3	90.6	73	25.2	91.4	74	46.5	92.6	78	70.5	93.3	84	97.0	94.1	90	124.3	94.7	96	156	95.2	103	191	95.6	111	233	96.0	120	278	96.4	130
		3½	19.5	91.4	72	23.0	92.1	73	42.5	93.2	77	65.0	93.9	81	88.7	94.6	86	113.5	95.2	91	144	95.6	97	176	96.0	104	214	96.4	111	255	96.7	120
		4	18.1	92.0	71	21.4	92.7	72	39.5	93.7	75	60.6	94.3	79	82.5	95.0	83	106.0	95.5	88	134	95.9	93	164	96.3	98	200	96.6	104	238	96.9	112
4	4½	1	51.7	81.9	95	60.7	83.6	88	111.7	85.9	104	170	87.4	123	229	88.9	142	292	90.2	163	365	91.2	187	443	92.9	213	515	92.9	242	725	93.5	274
		1½	39.2	86.2	79	46.3	87.5	81	85.3	89.2	92	130	90.3	105	177	91.5	118	225	92.5	132	283	93.2	148	344	93.9	165	398	94.4	186	473	95.0	208
		2	32.6	88.6	76	38.4	89.7	78	70.5	91.1	86	108	92.0	95	146	92.9	105	187.5	93.7	115	236	94.3	127	288	94.9	140	332	95.3	155	395	95.7	171
		2½	28.2	90.1	74	33.2	91.0	75	61.3	92.2	82	93.7	93.0	89	127	93.8	96	164.0	94.5	104	205	95.1	114	250	95.6	124	287	96.0	136	343	96.3	149
		3	25.1	91.2	73	29.5	92.0	74	54.8	93.1	79	83.6	93.8	85	113.5	94.5	91	146.0	95.1	97	184	95.6	105	225	96.0	113	257	96.4	123	306	96.7	134
		3½	22.9	92.0	72	27.0	92.7	73	49.7	93.7	77	76.5	94.3	82	103.8	95.0	87	133.0	95.5	93	167	96.0	99	205	96.4	106	233	96.7	114	278	97.0	123
		4	21.1	92.6	72	25.0	93.3	72	46.0	94.2	76	70.6	94.8	80	96.0	95.4	84	123.0	95.9	89	156	96.3	94	190[b]	96.6	100	215	96.9	107	257	97.2	115
6	6½	1	70.0	82.3	86	82.5	48.5	84.1	152	86.3	106	230	87.7	126	312	89.3	146	396	90.6	167	497	91.6	192	605	92.5	218	725	93.2	249	853	93.9	282
		1½	52.5	86.7	80	61.9	36.4	88.1	114	89.7	93	173	90.8	107	235	91.9	121	300	92.9	135	374	93.6	152	458	94.3	171	555	94.8	192	660	95.3	215
		2	42.8	89.2	77	50.5	29.7	90.3	93	91.6	87	142	92.4	97	192	93.4	107	247	94.1	118	310	94.7	131	380	95.3	145	460	95.7	161	545	96.1	179
		2½	36.7	90.8	75	43.2	25.4	91.1	79.5	92.8	83	122	93.5	91	166	94.3	99	213	95.0	107	267	95.5	117	327	96.0	128	396	96.3	141	473	96.6	155
		3	32.3	91.8	74	38.1	22.4	92.6	70.3	93.6	80	108	94.2	86	147	95.0	93	187	95.5	100	236	96.0	108	289	96.4	117	352	96.7	128	420	97.0	139
		3½	29.2	92.6	73	34.5	20.3	93.4	63.5	94.3	78	97.5	94.8	83	132.5	95.4	89	170	96.0	95	214	96.4	102	262	96.7	109	320	97.0	118	331	97.3	128
		4	26.7	93.2	72	31.6	18.6	93.9	58.4	94.7	77	89.5	95.2	81	122	95.8	86	156	96.3	91	197	96.7	97	242	97.0	103	292	97.3	111	350	97.5	119
8	8½	1	88.4	82.1	86	104.0	46.9	84.1	191.0	86.3	107	289.0	88.0	127	394	89.5	147	500	90.8	169	623	91.8	195	757	92.7	222	915	93.4	253	1080	94.0	286
		1½	65.5	86.7	80	77.5	34.9	88.2	142.0	89.8	94	217.0	91.0	108	293	92.1	122	376	93.1	137	472	93.8	155	573	94.5	174	693	95.0	196	822	95.4	220
		2	53.0	89.3	77	62.3	28.1	90.5	115.0	91.8	88	176.0	92.7	98	238	93.6	109	307	94.4	120	384	95.0	133	468	95.5	148	570	95.9	164	675	96.3	183
		2½	45.0	90.9	75	53.0	23.9	91.9	98.0	93.0	83	150.0	93.8	92	204	94.6	100	260	95.2	109	328	95.7	120	400	96.1	131	486	96.5	144	580	96.8	159
		3	39.6	92.0	74	46.6	21.0	92.9	86.0	93.9	81	132.0	94.6	87	176	95.2	94	229	95.8	102	289	96.2	110	353	96.6	120	429	96.9	131	510	97.2	143
		3½	35.5	92.8	73	41.8	18.8	93.6	77.0	95.5	79	118.0	95.1	84	161	95.7	90	206	96.2	96	260	96.6	104	318	96.9	111	386	97.2	121	462	97.4	131
		4	32.2	93.5	72	38.0	17.1	94.2	70	95.0	77	108	95.6	82	146	96.1	87	188	96.5	92	238	96.9	99	281	97.2	105	352	97.4	113	423	97.7	122
10	10¾	1	107	82.4	86	126	45.9	84.2	232	86.4	107	352	88.2	128	475	89.6	149	605	90.9	171	755	91.9	196	920	92.8	224	1110	93.5	255	1300	94.1	289
		1½	79	87.1	80	93	33.8	88.3	172	90.0	95	260	91.2	109	352	92.3	123	450	93.2	139	566	94.0	157	690	94.6	176	832	95.1	198	987	95.5	223
		2	63.2	89.6	77	75	27.2	90.6	138	91.9	88	210	92.9	99	286	93.8	110	366	94.5	121	460	95.1	135	558	95.6	149	676	96.0	167	805	96.4	186
		2½	53.6	91.2	75	63	22.9	92.1	117	93.2	84	178	94.0	92	242	94.7	101	310	95.4	110	390	95.9	121	476	96.3	133	577	96.6	147	687	96.9	162
		3	46.7	92.4	74	55	20.0	93.1	101	94.1	81	155	94.8	88	211	95.4	95	271	96.0	102	340	96.4	112	418	96.7	121	505	97.0	133	605	97.3	146
		3½	41.8	93.2	73	49	17.9	93.8	91	94.7	79	139	95.3	85	189	95.9	91	242	96.4	97	305	96.8	105	374	97.1	113	453	97.3	123	542	97.6	134
		4	38.0	93.8	72	44.5	16.2	94.4	82.5	85.2	77	126	95.7	82	172	96.2	88	220	96.7	93	278	97.0	100	340	97.3	107	412	97.6	115	495	97.8	125
12	12¾	1	123.5	82.7	86	148	84.4	90	271	86.6	108	410	88.2	128	555	89.7	149	707	91.0	172	883	92.0	198	1070	92.9	225	1290	93.6	257	1520	94.2	291
		1½	90.0	87.3	81	109	88.6	83	200	90.2	95	303	91.3	109	410	92.4	124	527	93.3	140	660	94.1	158	800	94.7	178	970	95.2	201	1150	95.6	225
		2	71.3	89.9	77	86.7	90.9	79	159	92.1	88	244	93.0	99	360	93.9	111	422	94.6	122	530	95.2	136	650	95.7	151	785	96.1	169	930	96.4	188
		2½	59.5	91.5	75	73.0	92.3	77	135	93.4	84	206	94.1	93	278	94.9	102	357	95.5	111	450	96.0	122	550	96.4	134	667	96.7	149	795	97.0	164
		3	51.7	92.6	74	63.0	93.3	75	116.5	94.2	81	179	94.9	88	242	95.5	96	312	96.1	104	392	96.5	113	476	96.8	123	582	97.1	135	695	97.4	148
		3½	45.7	93.4	73	56.2	94.1	74	104	94.9	79	159	95.5	85	216	96.0	92	277	96.5	98	350	96.9	105	427	97.2	115	520	97.4	125	620	97.6	136
		4	41.0	94.0	72	51.0	94.6	73	94	95.4	78	144	95.9	83	196	96.4	88	252	96.8	94	316	97.2	101	390	97.4	108	470	97.6	117	563	97.8	126
13	14	1	138.5	82.9	86	163	84.6	90	300	86.8	108	417	88.3	128	615	89.8	149	785	91.1	172	975	92.1	198	1190	92.9	225	1430	93.6	257	1680	94.3	291
		1½	101.0	97.5	81	120	88.7	83	224	90.3	96	336	91.4	110	455	92.5	125	583	93.4	141	730	94.1	159	887	94.7	179	1070	95.2	202	1270	95.7	227
		2	81.0	90.0	78	95.5	91.0	79	176	92.3	89	268	93.1	100	364	94.0	111	465	94.7	123	585	95.3	137	715	95.8	152	865	96.1	170	1030	96.5	189
		2½	68.0	91.6	76	80.0	92.5	77	148	93.5	85	226	94.2	93	306	94.9	102	392	95.5	112	495	96.0	123	605	96.4	136	734	96.7	150	870	97.0	166
		3	59.0	42.8	74	69.5	93.5	75	128	94.4	82	197	95.0	89	267	95.6	96	342	96.1	104	430	96.5	114	527	96.9	124	630	97.2	136	762	97.4	149
		3½	52.5	93.6	73	61.5	94.2	74	113	95.0	80	175	95.5	86	237	96.1	92	304	96.6	99	385	96.9	107	470	97.2	115	567	97.5	126	680	97.7	137
		4	47.3	94.2	73	55.5	94.8	73	103	95.5	78	158	96.0	83	214	96.5	89	275	96.9	95	347	97.2	101	425	97.5	109	517	97.7	117	615	97.9	127
15	16	1	158.0	83.0	87	187	84.7	90	342	86.9	108	513	88.4	129	700	89.9	150	895	91.2	173	1120	92.1	199	1350	93.0	227	1630	93.7	259	1920	94.3	294
		1½	115.0	87.7	81	136	88.9	83	250	90.4	96	381	91.5	110	515	92.6	125	660	93.5	141	823	94.2	160	1000	94.8	180	1210	95.3	203	1430	95.7	228
		2	91.5	90.2	78	108	91.2	79	198	92.4	89	304	93.2	100	410	94.1	111	525	94.8	124	650	95.3	138	805	95.8	153	975	96.2	171	1160	96.5	191
		2½	76.5	91.8	76	90	92.6	77	167	93.6	85	255	94.3	94	345	95.0	103	440	95.6	113	555	96.1	124	680	96.5	136	825	96.8	151	980	97.1	167
		3	66.5	92.9	74	78	93.6	76	144	94.5	82	220	95.1	89	300	95.7	97	384	96.2	105	483	96.6	114	587	97.0	125	715	97.2	137	850	97.5	150
		3½	58.0	93.7	73	69	94.3	74	128	95.1	80	195	95.6	86	265	96.2	92	341	96.6	99	427	97.0	107	525	97.3	116	638	97.5	126	760	97.7	138
		4	53.0	94.3	73	62	94.9	73	115	95.6	78	176	96.1	84	239	96.6	89	308	97.0	95	386	97.3	102	475	97.5	110	575	97.8	119	690	98.0	129

*Increase in heat loss from lagged surfaces when subjected to windage:

(*a*) According to Bagley in the 'Proceedings of the American Society of Mechanical Engineers,' December 1918, the increase in heat lost from lagged pipes with wind at 30 m.p.h. is of the order of 40% more than the heat loss in still air.

(*b*) According to Cammerer in 'Der Warme und Kalteschutz in der Industrie,' the increase above the still air loss: + 10 to 12% at 10-m.p.h. wind; + 13 to 15% at 50-m.p.h. wind. It is said that Cammerer's findings more closely resemble the loss when pipes are lagged to the above specifications.



[W. H. Allen, Sons & Co. Ltd.

A 350-kw. pass-out geared d.c. turbo-generator installed in a chemical works. Steam conditions: 150 p.s.i.g., 566° F. total temperature, 28½ in. vacuum. Process steam: 8,000 lb./hr. at 15 p.s.i.g. Speed: 7,000/1,000 r.p.m.

gases, or heating up the feed stock with the finished product. Condensate return can be heated in this manner.

Measurement of steam in process plants

There is always some discrepancy between the amount of steam metered at the boiler house and the steam metered at the process plants, and is usually referred to as 'unaccounted steam.'

There is bound to be some loss from steam mains, but this should not exceed about 6% if the lagging is in good condition. During one of the Ministry of Fuel and Power Surveys it was discovered that a factory had a regular 16 to 20% unaccounted for steam and each plant was metered. When the steam pressures were checked at each meter and the meter readings corrected for density it was discovered that the unaccounted for steam amounted to a little over 1%. This is well worth remembering when compiling a heat balance.

They record that on another occasion a battery of Lancashire boilers showed an overall thermal efficiency of 82%, a truly phenomenal result for this type of boiler. But when the wetness of the steam was determined it was discovered that the actual efficiency was 51%.

Whenever possible a regression line should be plotted for each plant. Plot steam, power and water against pounds of product and find what the soaking load is when the plant is not producing products. That is, the steam consumed by the plant before any product is made. In many cases this will indicate what order of saving is possible. It will, over a period of time, point out the need for new lagging, overhaul of steam traps, leaking steam valves, etc. It may even indicate where redesign of items of equipment is justified or modifications in the process cycle are necessary, particularly where large buffer storages have to be kept hot. (Table 2.)

POWER GENERATION

The ideal system is to generate steam at the highest pressure and temperature possible, expand through a turbine or engine and exhaust at the lowest pressure suitable for the process equipment.

Broadly speaking, there are two main sets of conditions.

(1) Where the factory steam load is high and the power load is small. This is the case where back pressure machines are most suitable.

(2) Where the factory steam load is small and the power load is comparatively great. In this case pass-out condensing sets are more satisfactory.

Obviously, unless there is only one continuous process being operated it is virtually impossible to balance the steam and power loads.

Large installations frequently combine the two systems and use the condensing set to handle the peak power loads. Peak steam loads are usually met by the use of a reducing valve, but a steam accumulator is by far the better proposition if it can be used. The efficiency of the steam and power balance can be estimated from the amount of steam passed through the reducing valve and the electricity purchased from the public supply.

Some idea of the possible savings by the use of back pressure turbines can be gleaned from a comparison of two hypothetical factories (Table 3).[2] Both require 28,000 lb. of steam for process and

Table 3. Savings Obtainable by using Back Pressure Turbines

DIVIDED SCHEME (FACTORY 'A') *1,000 kw. from public supply*		COMBINED POWER AND PROCESS STEAM (FACTORY 'B') *1,000 kw. from back-pressure turbines*	
CAPITAL OUTLAY	£	CAPITAL OUTLAY	£
Boiler plant	12,250	Boiler plant	17,000
		Turbo alternator (1,000 kw.)	12,000
		Alternator control	2,000
			£31,000
ANNUAL CHARGES		ANNUAL CHARGES	
Coal:		Coal:	
$\frac{1{,}133 \times 28{,}000 \times 3 \times 40 \times 50}{0.7 \times 12{,}000 \times 2{,}240}$	10,120	$\frac{1{,}271 \times 28{,}000 \times 3 \times 40 \times 50}{0.72 \times 12{,}000 \times 2{,}240}$	11,030
Labour (two attendants) ..	600	Labour (four attendants) ..	1,200
Interest 5%, depreciation 5% ..	1,250	Interest 5%, depreciation 5%	3,100
Maintenance	50	Maintenance	100
Electricity charges			
Kva. $= \frac{1{,}000 \times 4}{0.8}$	5,000		
Kwh. $= \frac{0.7 \times 1{,}000 \times 40 \times 50}{240}$	5,840		
	£22,860		£15,430

The capital cost is increased by £18,750 and the direct annual saving, before tax, is £7,430 p.a.

It is often advantageous to parallel with the grid and, in this way, power is taken from the grid to meet the factory peak loads and is fed back into the public supply when the factory loads are light. The power purchased will cost more than the power sold. Each case must be decided on its merits; it is not possible to adhere to any hard and fast rules, as conditions vary widely in different factories and different locations.

1,000 kw. of electrical energy. Factory 'A' uses live steam for process heating and purchases all its power from the grid, and Factory 'B' using back pressure turbines generates its own power.

The following data are assumed for purposes of comparison:

Heat per lb. of steam:	
Factory 'A'	= 1,133 B.Th.U./lb.
Factory 'B'	= 1,271 B.Th.U./lb.
Hours of operation (40-hr. week, 50 weeks/year)	= 2,000 hr./year
Coal	= £3 per ton
Boiler efficiency:	
Factory 'A'	= 70%
Factory 'B'	= 72%
Nett calorific value of coal	= 12,000 B.Th.U./lb.
Electricity maximum demand charge	= £4 per kva.
Cost of electricity per unit	= 0.7d.*

*This figure is rather higher than usual

Before leaving the subject of power generation, there is an interesting oil engine installation at Pinewood Film Studios in Buckinghamshire. This is an example of how an apparently difficult problem can be successfully solved by a rather novel design.

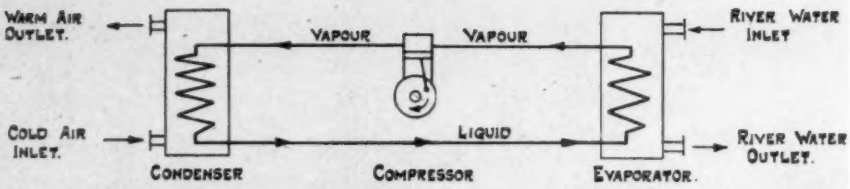
In a film studio[3] the power load is very considerable during the filming of a set, and falls very rapidly to a normal domestic lighting load between sets. The space heating load is heavy in winter and air conditioning is required in the summer.

When the studios were built, power from the public supply would have cost 13s. 10½d. per kva. per month plus 0.4625d. per unit, both measured on the high tension side. They therefore decided to be independent and generate their own power. Diesel engines were installed, coupled to d.c. generators supplying current to an acid accumulator system. The batteries are able to even out the peaks and enable the engines to operate on constant load, thus reducing the number of engines on load, at any one time.

The exhaust gases from the 4-stroke cycle engines at 670°F., when on full load, are passed through Clarkson thimble tube boilers, leaving the boilers at 300°F. The boilers were designed for use either 'wet' or 'dry,' and in addition to extracting the exhaust heat they also act as exhaust silencers.

Together with the cylinder jacket cooling water it is possible for the engines to take a considerable proportion of the space heating load. The efficiency of the exhaust gas boiler depends on the temperature of the exhaust gases. To prevent the exhaust temperatures from dropping too low, where the boiler efficiency became uneconomic and the gases approached their dew point, when the engines were on light load, electric immersion heaters were installed in the thermal storage vessel of the high pressure hot-water system. In this way the engine loads are maintained at their economic rating.

With this system it is possible to operate the station with a thermal efficiency of 75% in winter, 52% in summer with an average figure of 65% all the year round.



Flow diagram of a heat pump, illustrating space heating from river water. Heat abstracted from evaporator + heat of compression = heat given up in condenser.

$$\text{C.O.P.} = \frac{\text{Heat given up in condenser}}{\text{Heat equivalent of work done by compressor}}$$

GAS TURBINES

Gas turbines have been installed as follows:

(1) To run on blast furnace gases.
(2) Gas works waste heat.
(3) Contact nitric acid plants. It is reported that a saving of 15s. per ton of acid on a 50-ton per day unit has been made.
(4) Sewage plants.
(5) Production of tonnage oxygen.

The capital cost is high and this is partly due to the expensive materials of construction and also the heavy development charges of this type of equipment. Depending on whether it is a simple or closed cycle the installed cost is of the order of £40 to £70 per kw.

For example, the turbine blades of the Metropolitan Vickers unit in the Trafford Park power station cost £14 each.

Gas turbines are particularly useful for locations where cooling water is not available.

They are more economical in countries where gas and liquid fuels are cheap in comparison with solid fuels.

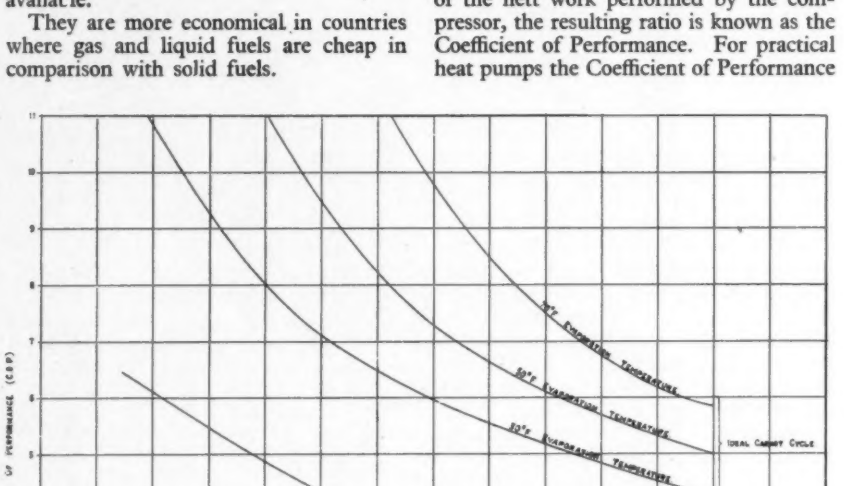
When considering a possible installation it is worth remembering that the exhaust gases contain a high oxygen content which can be used as pre-heated air for a boiler plant, or hot air for spray drying where products of combustion are not harmful to the product.

Gas turbines have a further advantage in that they can be put on load within 7 to 8 min. from starting up from cold for the open cycle machines and 35 to 40 min. for the closed cycle. The present-day thermal efficiencies are between 19% and 29%, depending on the design.

HEAT PUMPS

The heat pump is similar in principle to the vapour compression refrigerating plant. The heat abstracted from a cool body is elevated to heat at a higher temperature by means of compression. The heat pump is an application of the reversed Carnot Cycle as applied to refrigeration.

The heat output from the condenser is the sum of the heat removed from the cold medium and the heat of compression. If this figure is divided by the heat equivalent of the nett work performed by the compressor, the resulting ratio is known as the Coefficient of Performance. For practical heat pumps the Coefficient of Performance



Graph shows variation of C.O.P. with the difference in temperature between the source of low-grade heat (evaporation temperature) and the output heat distribution system (condensation temperature).

is 3.5 to 5.0. In some special cases it may be as high as 15.

If the C.O.P. is multiplied by $\frac{33{,}000}{778}$ (*i.e.* 42.4), then the product of this multiplication is B.Th.U./H.P. min.

The heat pump principle has been applied in many industries, particularly in evaporation, crystallisation and drying. Where power is cheap the heat pump finds its application where input and output temperature levels are not too widely separated. On the other hand, when the cost of power is high the economic balance moves in favour of a high initial capital cost with consequent rise in the coefficient of performance. A number of small horsepower units have been experimented with on a domestic scale both in this country and in the U.S.A. The low-grade heat is taken from a river, air or the ground. Many applications suggest themselves, and the most promising is the case where heat is to be removed from a process and added to another process. An excellent example of this may be found in Switzerland, where a heat pump installation is used to maintain an ice rink and at the same time heat the water of a swimming pool.

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[2] 'Power from Process Steam,' W. H. Allen Sons & Co. Ltd., Bedford.

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Fuel and Power in the Chemical Industry

A SYMPOSIUM on 'Fuel and Power in the Chemical Industry' was held on Friday, April 23, at Battersea Polytechnic, London. This meeting, which was organised by the Graduates' and Students' Section of the Institution of Chemical Engineers, was attended by over 150 members and visitors.

The first session was presided over by Prof. T. R. C. Fox, who referred to the valuable part played by such meetings in bringing together the young engineers and the older and more experienced men. The informal discussions which ensued were, he thought, almost as important as the papers read at these meetings. He then introduced a number of speakers, the first of whom was Dr. A. Parker, Director of the Fuel Research Station, D.S.I.R. Dr. Parker reviewed world sources of power, present and future, and showed how this country lagged far behind the U.S.A. both in availability of power and in power resources. He considered wind and tidal power to be only of marginal value and pointed out that the problem of developing atomic energy for power production was perhaps more important in Great Britain than anywhere else.

Dr. Parker was followed by Mr. Paddon-Row, of Foster Wheeler Ltd., who discussed some aspects of steam generation in chemical works. Particular reference was made to gas- and oil-fired boilers, but little mention was made of waste-heat boilers, although the opportunity for their use occurs so often in process industries.

The next speaker, Mr. J. J. Priestley, chief research engineer of W. C. Holmes Ltd., dealt with some chemical engineering problems encountered in gas manufacture. The difficulty of heat transfer to coal in retorts received special mention and reference was made to new developments in gasification, especially the Lurgi process. Mr. Priestley then dealt in some detail with gas absorption problems in gas purification.

The morning session ended with a talk by Mr. D. P. Plummer, of Shell Refining & Marketing Ltd., on the production of heavy fuel oils. After defining heavy fuel oils both from the consumer's and supplier's points of view, Mr. Plummer went on to deal with questions of viscosity index and stability. He referred briefly to the limitations of mineral and sulphur content in commercial oils. At the conclusion of these four papers a lively discussion took place.

The meeting was resumed after lunch, the chair on this occasion being taken by Sir Harold Roxbee-Cox. The first speaker in the afternoon session was Mr. R. S. Cleggs, of the British Aluminium Co. Ltd., who dealt with the use of electricity in the electrochemical industry. Mr. Cleggs showed that the efficiency of an aluminium reduction cell could be expressed as $(x + 50)\%$, where x was the percentage of CO in the gas from the cell. The main factor in producing aluminium was, of course, cheap electricity, and the cost of generation from coal was prohibitive for this industry.

Mr. B. Reavell, of Kestners, followed and discussed the use of steam in evaporation. He laid stress on the economy of double effect plus vapour recompression as against conventional multiple-effect systems. Of particular interest was his description of the closed-cycle evaporating unit which used a suitable heat-transfer medium as both the heating and the cooling fluid. Such a system was suitable only for operation at low temperatures, but had considerable advantages when dealing with heat-sensitive products.

Mr. R. F. Hayman next described the works of the Industrial Advisory Section of the Gas Council and in particular gave instances of the application of gas in process heating.

He was followed by Mr. D. A. Monk, of Peabody Ltd., who presented a paper on the burning of heavy fuel oils. Mr. Monk dealt principally with burner design and described self-atomising, air-atomising and steam-atomising systems, all suitable for use with this fuel. Generally, steam atomisation is preferred, however, because of the greater flexibility in dealing with fuels of slightly different properties. He stressed the importance of operating at the correct steam pressure and stated that most burners were worked with atomising steam at much higher pressures than the optimum. This was because excess steam gives a whiter flame but the overall efficiency is lower.

Prof. R. J. Sarjant then gave a talk on recent advances in fuel economy. He surveyed the main theoretical and practical advances made over the last 30 years and concluded that we were now very much nearer to his ideal, which was to be able to design fuel using equipment from first principles.

After an interesting discussion on these papers the proceedings were summed up in a short contribution by Prof. F. H. Garner.

Pumps in great variety are illustrated in a new 6-pp. folder from Girdlestone Pumps Ltd. Altogether 37 units are featured under the headings: diaphragm pumps, engine sets, electric sets, float switches, centrifugal pumps, motor pumps and rotary pumps. Industrial installations are illustrated.

Crucible melting. A new illustrated pamphlet by the Morgan Crucible Co. Ltd. shows the company's range of crucible furnaces, including the hydraulically-tilted lip-pouring furnace, oil- or gas-fired lift-out furnaces, the rotary crucible furnace, the miniature furnace, the central axis-tilting furnace, the coke-fired lift-out furnace, the bale-out furnace, and the crucible heater. A further pamphlet issued by Morgan explains the advantages of crucible melting.

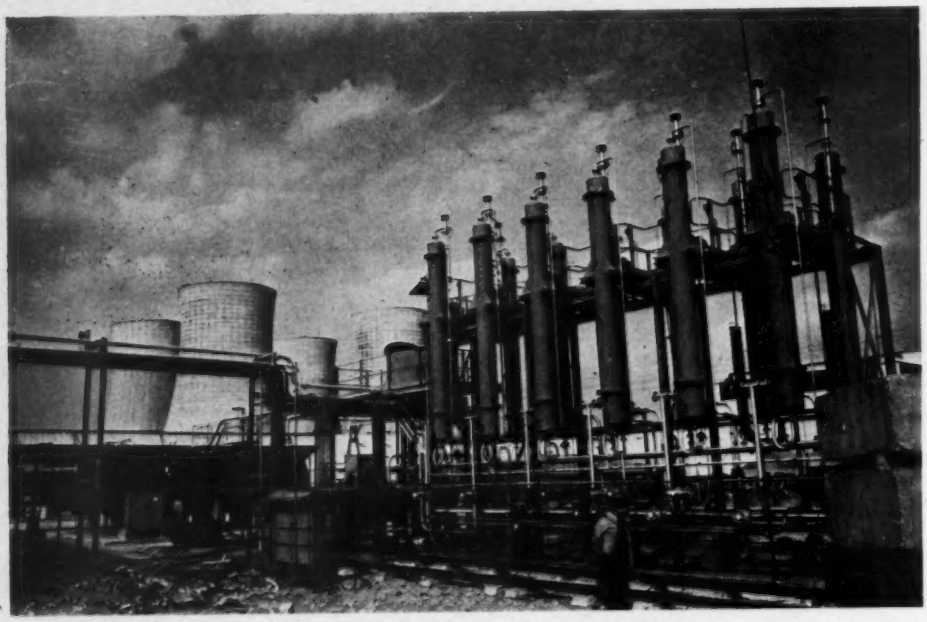
Nuclear Engineering in Britain

NEW PICTURES OF THE ATOMIC FACTORIES

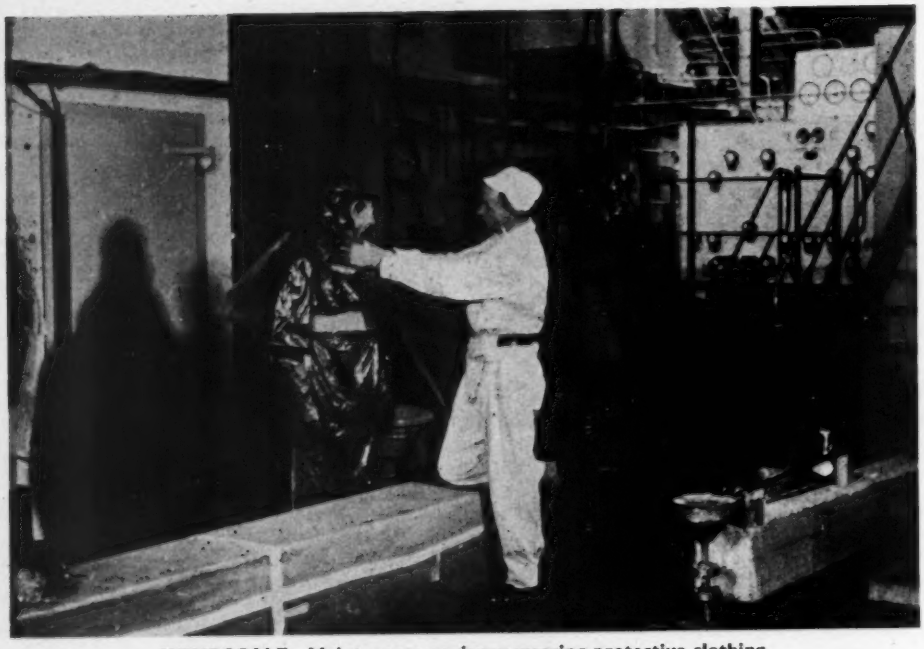
BRITAIN'S atomic energy industry, worth scores of millions of pounds and employing thousands of workers, already produces large quantities of atomic fuel and holds promise of abundant power for the industry and homes of tomorrow. In our March issue we referred to the building of Britain's three atomic factories as a chemical engineering triumph and described briefly how the major problems of design and construction were tackled. The full story is told in the book 'Britain's Atomic Factories.'

The four photographs reproduced here have just been released by the government.

Two of them (bottom left and top right) strikingly show the elaborate measures taken to protect engineers and process workers against radioactivity; this aspect of atomic energy production created some formidable problems for the engineers who designed and built the factories. The primary separation plant at the Windscale plutonium factory, for instance, is so intensely radioactive that every operation and control is done from behind thick walls of concrete and the plant had to be designed with the consideration in mind that, once started up, access for maintenance would be out of the question.



CAPENHURST. Gas scrubbers and cooling towers.



WINDSCALE. Maintenance engineer wearing protective clothing.

In the gaseous diffusion plant at Capenhurst (top left), where uranium 235 is produced, there is no strong beta-gamma or neutron radiation to contend with, but all the process units and the miles of pipes connecting them have to be kept at moderately high temperature, must be perfectly clean inside, and must be vacuum-tight. Another difference between this and the other atomic energy plants is that there is no active effluent, either liquid or gaseous.

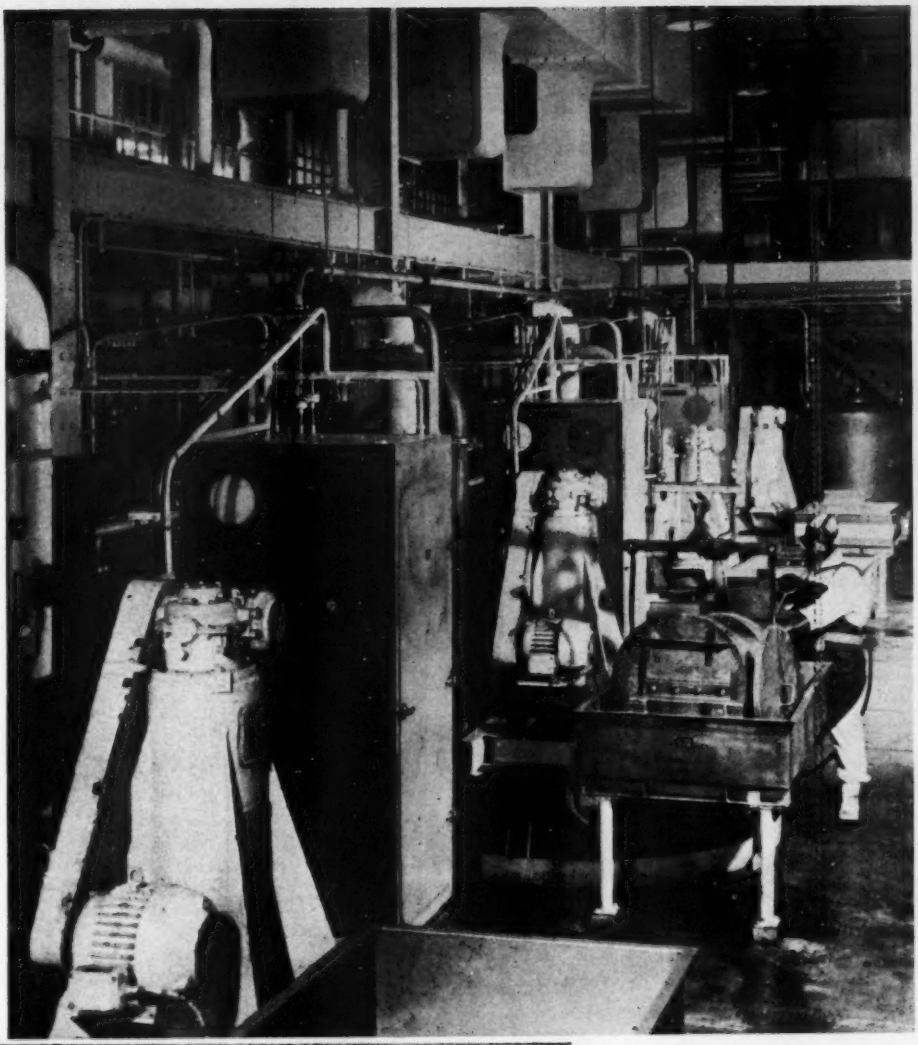
Large quantities of water are used to cool the gas after compression but this water is not discharged to waste; after it has performed its work it is pumped through cooling towers and then recirculated through the plant.

Uranium production

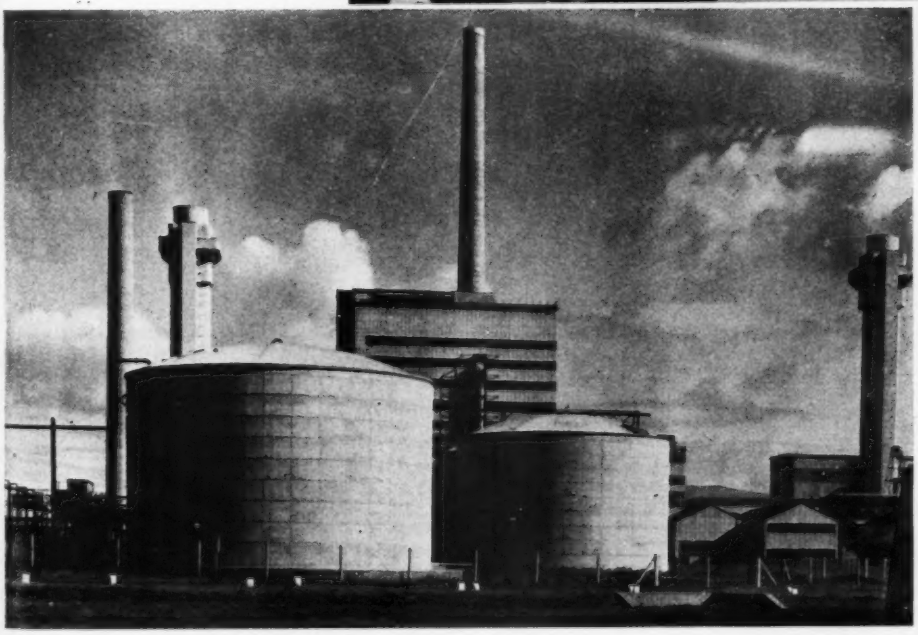
At Springfields, the oldest of Britain's three atomic factories, the methods used for the extraction of the crude uranium oxide from the ore and its subsequent purification

by solvent extraction, are characteristic of the heavy chemical industry. The chief novelty is in the use of large quantities of hydrogen peroxide, a dangerous chemical that has not before been used on this scale in Great Britain. Much useful information about handling hydrogen peroxide in quantity was obtained from the records of German wartime scientists who used it as a launching propellant for flying bombs...

The final processes at Springfields, which are concerned with converting pure ammonium diuranate to metallic uranium, are characteristic of a metallurgical works. The diuranate is converted to the metal in two stages; in the first it is converted to pure uranium tetrafluoride by heating the powder in electric furnaces, reducing it, and then passing over hydrogen fluoride gas at the appropriate temperature; this results in the formation of solid uranium tetrafluoride. This fluoride is then removed from the furnace, mixed with chips of calcium metal in a mould, and fired, resulting in its reduction to metal.



SPRINGFIELDS. Dissolvers in the uranium production plant. Note the gloved and masked workman clad in protective clothing.



WINDSCALE. *Left and right,* **the two production piles, and, beneath the tall chimney in the centre, the primary extraction plant.**

Atomic Energy Chief Acknowledges Help of Chemical Engineers

Sir John Cockcroft's Speech at Chemical Engineers' Dinner

AT the annual dinner of the Institution of Chemical Engineers held in London on April 30 under the presidency of Mr. Stanley Robson, the chief guest was Sir John Cockcroft, F.R.S., Director of the Atomic Energy Research Establishment, Harwell. Sir John Cockcroft said:

'I am honoured by this opportunity of proposing the toast of the Institution of Chemical Engineers and in so doing to acknowledge the help we have received from members of your Institution. Chemical Engineering in this country is relatively new to the older primary technologies of the Civils, Mechanicals and Electricals. Nevertheless, after the initial doubts as to whether an offspring of the Chemists and Mechanicals could possibly be wanted or be legitimate, your profession is rapidly establishing itself as our fourth primary technology. This is shown by your membership which is now over 3,000 and by the foundation or approaching foundation of no less than four university Chairs in this field during the last year. It is interesting to note, however, that the doubts about your origin are still held in some academic quarters, since one of these Chairs is to be a Chair of Chemical Technology and another associated with Industrial Chemistry. Nevertheless, your student numbers grow and I am told should soon have an annual enrolment for first degree courses of 200, and 50 or so for higher degrees and appreciable numbers in technical colleges.

Scarcity of chemical engineers

Judging by the difficulties we experience in obtaining qualified graduates, the numbers being trained are still too few and it would appear that the estimates of requirements made five years ago by the Hankey Committee were too conservative.

If we look across the ocean to our friends in the United States, where we can often see the shape of things to come more clearly than at home, we see first the enormous expansion of the chemical engineering industry; we see an Institution with a membership of 13,000; and we find that the annual graduate students are 4,000, about 20 times our numbers.

In this country, the Government, through the Ministry of Supply and the Department of Atomic Energy, has become a substantial user of chemical engineering and the Ministry of Supply has established a "practice school" at the Bridgwater R.O.F. and has also founded vacation consultantships and studentships at R.O.F.s and research establishments, and we have benefited from this at Harwell, where we have a very flourishing Chemical Engineering Division, including nine Associate members and eight student members of your Institution. I have no doubt, in seeing them at work over the last seven years, of the important rôle they play between the chemist who usually does the pioneering test-tube work, and the engineer who designs and builds the plants. I believe that scientific design focussing itself round the pilot plant can save enormous sums in final plant construction and operating costs. I once heard a U.S. estimate that plants built without a pilot plant often cost three times as much as those based on adequate pilot-plant experience.

I have also seen much new technological development based on processes such as solvent extraction, ion-exchange separation and fluidised-bed techniques, and realised what importance these playgrounds of the research chemical engineer hold for the future.

Enrolling the young

I am glad to see also that the Institution is taking the initiative in diverting more of our schoolboys at their critical age into technology, and your publication, "Careers in Chemical Engineering," combined with your successful schoolboys' meeting in London, shows how to go about this problem which is vexing all the technologists. I am quite sure there is plenty of undeveloped talent available amongst the young if only their imagination can be captured during the formative years.

In proposing the toast of the Institution I have to couple it with the name of your president, Mr. Stanley Robson. I came to know Mr. Robson through his son, who worked with me at Malvern on the development of radar during the war, and in Chalk River at the end of the war and since. The high qualities of this "chip off the old block" were an indication to me before I met your president of his own qualities. And so I am very glad to be able to propose the toast of the Institution of Chemical Engineers.'

President's reply

Responding to Sir John Cockcroft, Mr. Stanley Robson welcomed his remarks on the rôle of the chemical engineer in creating the vast new atomic energy industries. Commenting on the publication 'Careers in Chemical Engineering,' he said that it had attracted many enquiries. Even schoolgirls had asked for copies and he wondered if in the next decade women would enter the ranks of chemical engineers.

The chairman of the Institution's North-West Branch, Mr. P. K. Standring, proposed the health of the guests, among whom were the presidents and other officials of kindred Institutions and Government research establishments.

Replying for the guests, Sir William Ogg, president of the Society of Chemical Industry and head of the Rothamsted Experimental Station, made a characteristically witty speech. He supposed that even in the Garden of Eden a chemical engineer was somewhere around, probably in connection with the compost heap, but, of course, he would not be engaged in making it but in directing someone as to how it should be made.

On this humorous note the speeches ended, whereupon Mr. Robson invested his successor, Sir Harold Hartley, with the presidential chain. Mr. Robson remarked that it was unusual for a president to hand over the insignia to the person from whom he had received it. He was indeed glad that Sir Harold had been persuaded to resume the office which he relinquished in 1952.

Sir H. Hartley again president of Institution of Chemical Engineers

Sir Harold Hartley, F.R.S., who was president of the Institution of Chemical Engineers for 1951-52, was re-elected president in succession to Mr. Stanley Robson at the 32nd annual meeting of the Institution in London on April 30.

Other elections were:

Vice-Presidents: Prof. F. H. Garner, Mr. J. M. Leonard, Dr. N. E. Rambush and Dr. B. Segal.

Joint Hon. Secretaries: Prof. M. B. Donald and Mr. F. E. Warner.

Hon. Treasurer: Mr. F. A. Greene.

Members of Council: Dr. E. H. T. Hoblyn, Dr. H. R. C. Pratt, Mr. K. B. Ross and Dr. H. W. Ashton (Associate Member).

Presidential address. Following the corporate meeting, Mr. Stanley Robson delivered his presidential address entitled 'Progress and Objectives.' Mr. Robson surveyed chemical engineering progress in Britain, giving special attention to the development of training facilities, the penetration of the chemical engineer into a wide range of industries and the division of membership by occupation such as administration, design, research and development. He showed that slightly more than half the members, excluding students, were employed in the chemical and allied trades, including mineral oil refining, and that 14% were employed in chemical plant manufacture.

Plant and Equipment

Fast fire extinguisher

A new type of pressure-operated, quick-action fire extinguisher, the *Chloro-Flash*, is being marketed by Nu-Swift Ltd.

The high-speed action claimed for the unit is said to be due to the low inhibitory factor of the chlorobromomethane content combined with its thorough atomisation by absorbed CO_2 under pressure. CBM has a low boiling point, 153°F., a low freezing point, −123°F., and high vapour density. It is said to produce less soot and smoke and less irritating and corrosive fumes than carbon tetrachloride.

The unit, which is easily carried, being less than 16 in. high, is claimed to be particularly effective on extra-hazardous risks such as all electrical equipment, *e.g.* switch gear, and medium-sized organic solvent fires common in laboratories, etc. The sealed pressurised charge and the low freezing point of CBM make it suitable for use in the tropics and also effective at arctic temperatures.

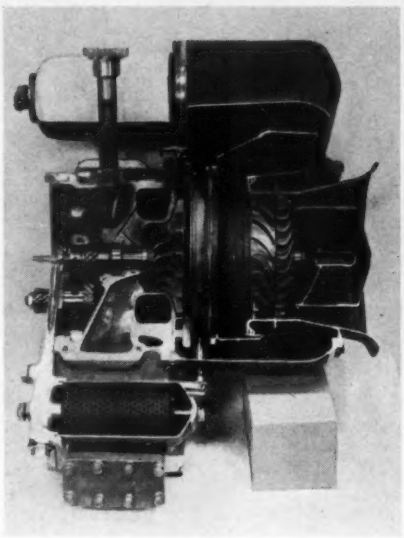
Model 2003 has been approved by the Fire Offices' Committee.

Industrial pH amplifier

This unit, intended for use by the chemical industry for indicating, recording and controlling *p*H values, has been produced by W. G. Pye & Co. Ltd. The *p*H amplifier is mounted in a case, flame-proofed to B.S.S. 229/1946. The circuit is basically that of the firm's direct-reading *p*H meter which employs a high degree of negative feedback providing very linear response, a sensitivity of 100 μa. per *p*H unit or 1 μa. per mv., and independence from mains variations or valve changes. In addition, full temperature compensation is provided. In the event of a fault the electronic unit or the power unit can be immediately removed from the case and replaced by a spare. Operating controls are fitted under a glass door which may be locked. Any of the three ranges 0 to 8, 3 to 11 and 6 to 14 *p*H may be selected by an internal switch. Controllers, recorders, indicators and alarms may be operated; external resistance up to 10,000 ohms may be used without affecting operation.

Small industrial gas turbine

The first small industrial gas turbine to go into production in Britain, the Rover 1S/60, was shown at the 1954 British Industries Fair in Birmingham. Among other applications, it can be used in any of the better-known process gas-turbine cycles, such as the Houdry oil cracking process, the Velox boiler and the Buchi supercharger. Because of its light weight (116 lb.), the unit can be incorporated into portable fire pumps, electric generators or



Portable gas turbine.

air compressors. Any distillate fuel may be used.

The engine is of the single-shaft type without heat exchanger and has a Plessey dual fuel pump and Lucas combined governor and temperature control. By means of this unit the engine is automatically controlled, the single lever required being a fuel 'shut-off' cock, used to stop the engine. The cycle arrangement includes a single-stage, single-sided, 17-vane centrifugal compressor.

Makers are Rover Gas Turbines Ltd.

Batch-type carbonitriding furnace

A batch-type furnace has been developed for producing a hard case on steels by carbonitriding, the treatment temperatures for which are some 100°C. lower than those used in normal carburising practice. It is a horizontal furnace in which the complete process including oil quench or, alternatively, cooling in the carbonitriding atmosphere may be carried out without exposing the charge to air and without cooling down the heating chamber.

The furnace is arranged for front operation. It has, in addition to the heating chamber, a purging section, an oil quench tank and a cooling chamber. The doors and quench gear are operated hydraulically. Both the cooling chamber and the quench tank are water-cooled and the latter is fitted with agitating propellers. The heating chamber has totally enclosed tubular elements.

Small parts can be processed in wire-mesh baskets loaded on a grid carrier tray. The tray is moved in and out of the furnace manually from a roller-top charging table. Alternative charge carrying platforms allow cooling or quenching to be carried out whilst another charge is in the carbonitriding chamber.

A furnace to take a batch of parts weighing 250 to 300 lb. will have an overall length, including charging table, of 13 ft. and a height of 11¾ ft. It will accommodate three baskets on a carrier tray 36 in. long by 24 in. wide by 15 in. high. General Electric Co. Ltd. are the makers.

Xeroradiography

A demonstration of this method of producing radiographs was given by Ferranti Ltd. at the Physical Society Exhibition held in London. An electrostatic image of the radiograph is obtained on exposing a charged plate which consists of a very thin film of selenium deposited on a conductive backing plate. The image is made visible by applying a very thin film of charged powder to the surface of the plate, the powder adhering in accordance with the charge distribution on the plate itself. For re-use it is simply necessary to wipe the plate clean and re-charge.

Exposure by this method is said to produce positive or negative radiographs in less than a minute. The process is also claimed to be economical, as the plates can be used many times.

Zirconiated welding electrodes

Electrodes used in argon arc welding are in theory non-consumable, *i.e.* they do not contribute to the weld metal. However, in practice, considerable wastage occurs mainly owing to the regrinding which is necessary to keep the electrode tip free from contamination. One of the most important requirements of an electrode of this kind is that it should retain a suitable point during welding in order to limit the width of the weld and to maintain a consistently stable arc throughout the welding operation. These conditions apply only to d.c. welding and in particular to thin sheet welds and high-speed automatic welding.

A pointed electrode will obviously become more easily contaminated than one with a broader working surface because in operation it will be hotter. During welding, contamination of the point occurs through particles of metal or oxide thrown up from the molten pool of the weld. Obviously the electrode can also be directly contaminated by touching the molten pool or by contact with the filler wire.

In the case of a pure tungsten rod, contamination means immediate regrinding. This is because contamination lowers the melting point of the tungsten and deterioration occurs rapidly. It is also difficult to maintain a suitable point with this type of electrode for similar reasons.

Thoriated tungsten electrodes, which incorporate thoria to increase their emission, have certain advantages over the pure tungsten type. It is easier to main-

tain a suitable welding point when using thoriated tungsten electrodes because they offer greater resistance to contamination than the pure tungsten rods and they also enable the arc to be re-struck more readily. However, direct contamination either by contact with the molten pool or filler wire necessitates the immediate regrinding of the electrode and in this respect it has, therefore, very little advantage over the pure tungsten type.

A new development by Murex Welding Processes Ltd., the zirconiated electrode, is claimed to show a considerable improvement over the thoriated tungsten electrode in its resistance to contamination. Even if the zirconiated electrode is deliberately allowed to touch the molten pool and the filler wire during welding, contamination, although present, does not ' wet ' the point of the electrode and form a globule on the tip as in the case of pure tungsten and thoriated tungsten rods. It is further claimed that it is possible to continue welding with zirconiated electrodes after contamination when, in similar circumstances, pure tungsten and thoriated rods would require immediate regrinding. The electrodes are made in sizes ranging from $\frac{1}{16}$ to $\frac{1}{4}$ in. outside diameter and 6 to 12 in. in length.

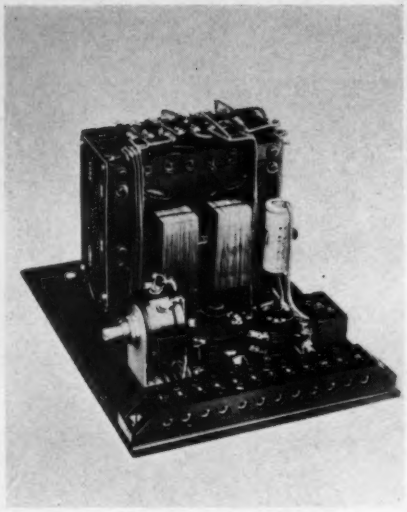
Recording balance

A recording balance to give continuous records of weight-change with time when used in conjunction with customers' own auxiliary equipment has been marketed by Stanton Instruments Ltd. The balance is air damped and suitable for a total load of 200 g.

The object whose change of weight it is required to follow may be located on the rear pan, or hung from it by means of a hook extending through the balance base. The sample may thus be located in a standard furnace, oven, refrigerator, humidity chamber, dry box or similar chamber containing the chemist's own favoured ' set-up.' The changes of weight are continuously indicated and recorded on a strip-type electronic recorder mounted above the balance.

The pen is power driven by a servo motor and receives its information from a capacity follower plate located over the balance beam. This plate has no direct or mechanical contact with the beam. Thus the balance may be arranged when manufactured for either 1-mg. sensitivity or for 0.1-mg. sensitivity with the same proportional accuracy of scale, it is claimed.

The unit can follow weight change up to ± 1 g. automatically. Once set, it will reproduce and record time and weight changes for several days. Three chart speeds are available and at the slowest speed the spool holds sufficient paper for 20 days' work. The recorder incorporates the Fielden *Servograph* patents and the electronic chassis used is of the ' plug-in ' type.



A magnetic amplifier that engineers can experiment with.

Educational magnetic amplifier

A single-stage magnetic amplifier which can be used for educational and experimental purposes has been developed by Electro Methods Ltd., so that engineers may satisfy themselves on its many applications and apply these methods to new fields of control equipment.

The amplifier is designed in such a way that its basic principles of working can be easily investigated. All the important measuring points are easily accessible and the circuit can be traced by following the colour coded connections.

The unit consists of a transformer-like structure comprising two magnetic cores of high-permeability nickel alloy so designed that a close approximation to a toroid is achieved. Each core carries two a.c. windings connected in series, the windings being connected so that the relative polarity of the fluxes in the two cores is opposite. The two cores are embraced by common windings, referred to as d.c. windings. Since these windings embrace the two cores in which the polarity and magnitude of fluxes is exactly opposite, there are no voltages of fundamental frequency induced into them.

The magnetic amplifier is provided with positive feed-back where the ampere turns are 100%, with an additional 5% which may be connected additively or subtractively as desired, thus giving 95 to 105% feed-back. A smooth control of self-excitation may be obtained between these limits by connecting a variable shunting resistor in parallel with the 5% winding, and a larger control of feed-back amp turns may be obtained by connecting the shunt across the 100% winding; however, this is not generally done, since the study of the effect of feed-back is more interesting when around 100%.

The bias may be varied by adjustment of the bias potentiometer, the current being provided by a small rectifier connected across the supply. A 25-μF. condenser is connected across the bias rectifier, its purpose being to prevent rectification of the induced harmonic currents circulating in the bias winding.

The bias current can be measured by connecting a 20-ma. instrument to the terminal block; for normal working this terminal block is bridged by a short-circuiting link.

Briefly the amplifier specification is as follows:

Supply voltage: 20 v. at 50 c/s. Input resistance: two independent windings of 100 ohms each, which may be connected in series or parallel or used independently. Recommended load: not lower than 30 ohms. Output power: 2.7 watts in 30-ohms load. Power amplification: 40,000 with 100% self-excitation in 30-ohms load.

The unit is supplied with full working instructions.

For further information about the Plant and Equipment described, use the coupon on page 194

Smoke control and heat recovery plant

T. F. Holmberg, M.S. technical manager of Oy Vuoksenniska A.B., Finland, describes the equipment recently erected at the company's Imatra works for recovery of waste heat and cleaning of flue gas, in *Teknillisen Kemian Aikakausilehti* (1954, 3, 51).

The device consists of a Venturi tube. The gas attains a high velocity in the narrow part of the tube where water is sprayed into the tube with the same velocity and in the same direction. A very homogeneous mixture of gas and water is thus obtained without energy losses. In the larger part of the tube the velocity of flow diminishes and the components are separated at the end of the tube. Close to 95% of the solids are to be found in the liquid phase. This means very efficient smoke control. The heated water can be used in the plant for central heating, etc., and the washer can be used as a heat exchanger by combining two devices.

The maintenance of the washer is said to be extremely simple and the price low. According to calculations presented, the latter is easily paid by the washer in the course of one year.

The equipment is carried out by A. Ahlström Co., Varkaus, Finland.

Chemical Engineering Methods in the Food Industry

By Sir Ben Lockspeiser, K.C.B., F.R.S.
(*Secretary, Department of Scientific and Industrial Research*)

The British food industry is well served on the biological and chemical side, but it has not enough trained engineers capable of translating the biologist's requirements into processes and plant. This is probably the main problem facing the industry today. Here the Secretary of the D.S.I.R. describes how Government and industrial organisations are co-ordinating their approach to the chemical engineering problems of the food industry. Sir Ben Lockspeiser made these remarks in opening the Conference on Chemical Engineering Methods in the Food Industry, held in London recently under the auspices of the Chemical Engineering and Food Groups of the Society of Chemical Industry.

THE scientific study of food is a modern growth and has provided the foundation for chemical engineering in the service of the food industry, one of the many branches of chemical technology. The lead which the United States hold in this latter field has arisen from the rapid growth of the American oil industry which created the need and provided the impetus. Chemical technology was reared there in the favourable environment of a vigorous industry that was conscious of the power of science and engineering from the beginning, and progressed rapidly from batch to continuous operation, through a series of bold innovations leading to self-working processes based on a high degree of instrumentation and automatic control. This has been of great value not only in itself but in creating an army of chemical engineers skilled in designing and making equipment for chemical processes of all kinds, including those concerned with the processing, storage and packaging of foods.

One of the main aims of progressive manufacturing industrialists in all branches of chemical engineering is the conversion from batch to continuous operation. Certain foods have for long been prepared by continuous methods, and food manufacturers are now reviewing and reorganising their processing lines with the emphasis on higher working speeds without prejudice to quality. But the insufficiency of basic scientific data is bound to prove a serious handicap in the designing of efficient equipment. These problems are many and various and involve studies in plant physiology and biochemistry in relation to the storage life of fruits and vegetables, in chemical studies of certain substances in foodstuffs which affect the changes in flavour and colour during the processing or storage, or in the changes occurring in dehydrated foods.

We know far too litfle also about the physico-chemical changes that occur or about the mechanism whereby changes are produced, as, for example, the migration of water in solids because of gradients in the moisture and temperature, or the effect of small quantities of ozone and ethylene in the atmosphere and the corrosion resistance of various protective coatings of metal containers. Factors such as these and many others in the field of biophysics, biochemistry and microbiological chemistry lie at the heart of the whole complex problem of the prevention of wastage in foods, ranging from the control of micro-organisms to the control or inhibition of chemical changes which result in breakdown products affecting flavour and storage and leading to what is generally known as 'spoilage.'

This is, however, only half the story. Mechanical knowledge must be brought to bear for a variety of purposes, such as grinding, mixing and agitation, and refrigeration, a vital engineering requirement for the preservation of food, calling for reliable data on heat and vapour transfer, both under normal conditions and at iced surfaces. Much of the required engineering data is peculiar to the food industry itself, but a good part is common to other fields. In the design of compressors, for example, great advances have been made in other fields on centrifugal and rotary types which the refrigerating engineer could turn to his advantage.

Importance of technology

All this adds up to a very formidable task, but food technology is not to be had by a process of addition. Food technology is a subject in its own right with a unity of its own, and like other advanced technologies of the present day must be treated as such if practical results are to be obtained. Technology calls the tune today, and the piper is the designer who must understand the engineering, the chemistry and the biology of the business. The food industry requires adequate staffs of biologists, chemists and engineers and it is essential for success that these groups should co-operate and understand fully the other's point of view. In this country the food industry is well served on the chemical and biological side, in research and control laboratories, but the insufficiency of trained engineers or technologists capable of translating the biologist's requirements is probably the main problem facing the industry. Apart from some large progressive concerns, few firms have a first-class engineering staff capable of undertaking intelligent development of machines in co-operation with the biologists. Piecemeal attack and divided control belong to a simpler and less sophisticated past. What is needed now is a comprehensive treatment of this all-important subject.

A start has been made on these lines by the setting up of a joint body comprising the Food Manufacturers Federation and the Food Machinery Association. So far it only meets to exchange views of current interest such as, for example, the need for certain types of equipment, the requirements of performance and likely demands from the user. But it is a welcome step in the right direction which would be immensely strengthened if funds and facilities for co-operative research were to be provided. Further action on these lines by the food manufacturers and food machinery makers could not fail to be of great advantage to progress in food technology in this country.

The establishment of the National College of Food Technology in 1951 was another welcome step and a particularly necessary one too in providing technological training covering the examination, handling, processing and preservation of food of all kinds. Regular teaching on the subject in the Universities and affiliated bodies is provided by courses at the Royal Technical College, Glasgow, on food technology and at Reading University on dairy technology, but it is doubtful whether the means are yet adequate to train a sufficiency of men capable of becoming leaders of the industry. There is a great demand for such men in the United States, trained in the Department of Food Technology at the Massachusetts Institute of Technology and other universities, and the extensive facili-

ties in the United States for training food technologists of this quality are no doubt due in a large measure to the extensive demand which the United States industry makes for them.

Food investigation organisation

Meanwhile, our task and duty must be to do all we can to promote the fruitful co-operation of research and industry. The purely competitive spirit of the food as well as of other industries has been considerably modified over the last thirty or forty years in favour of a move towards mutual exchange of information and mutual advantage. This has been reflected in the growth of the Research Associations. Supported by the Department of Scientific and Industrial Research, over forty such organisations exist, of which five Research Associations concern themselves to a greater or lesser degree with the processing of food, particularly in milling, baking, canning, fruit preservation and such foods as chocolate, cocoa, jams, pickles and sauces.

To meet the great need for information based on systematic observation and investigation the D.S.I.R. set up towards the end of the first world war the Food Investigation Organisation, whose functions were to break new ground in the study of the properties of foodstuffs of many kinds and to explore the possibilities of new and improved practical methods of storage, processing and distribution. The work of the organisation's laboratories, which now number six, has resulted not only in many scientific contributions on the biology of foodstuffs but in striking achievements in the applied field, such as new methods for storage and transport of fresh fruit, fish and meat as well as in a better understanding of processes such as canning, curing and dehydration, all of which require the determination of basic chemical engineering data.

Some of this work was carried out in collaboration with the Ministry of Food, particularly that on the technology of the dehydration of various classes of foodstuffs, work which was primarily undertaken to meet wartime needs and possible emergencies. It has been calculated that two or three million tons of water are imported into this country annually as part of our foodstuffs. We all prefer normal to dehydrated food, but it is satisfactory to know that we have accumulated a large proportion of the requisite data for reducing this transport of water by 80% should it ever become necessary. Nor should we overlook the savings which can be had from the reduction of waste in bulk storage of normal foods. The present narrow limits of safe storage of grain, for example, might become widened as a result of studies by the D.S.I.R. Pest Infestation Laboratory on the atmospheric conditions governing storage, and steady work is going on to ensure the conservation of supplies here and in the Commonwealth.

Laboratory scale research

Much useful engineering research can be carried out on a laboratory scale with comparatively simple apparatus and at no great cost. Typical examples are provided by the researches of the D.S.I.R. Food Investigation Organisation on the drying of foodstuffs by heated air, freezing and vacuum techniques, or by a recent request for research into the fundamentals of bacon smoking on the same lines as the work done by F.I.O. on the smoking of fish. A wide field for research is offered in the application of high-frequency techniques, ultrasonics and electronics to food processing. F.I.O. is also investigating the interactions between foodstuffs and aluminium and their inhibition, work which should be extended to other metals.

On somewhat larger plant the above work has been extended to cover blanching of foodstuffs; contact, blast air and immersion freezing of foods; compression and packaging of foodstuffs. Heating and cooling of viscous liquids in cans and heat transfer and frothing in evaporators are also typical of investigations suitable for this scale of research. It is not generally recognised or accepted that such a wide field exists for this type of laboratory 'food engineering' research and it is often confused with the more expensive development of pilot plant or pre-production stage, which involves the design and construction of plant bearing some relationship in scale to the final production unit and which requires collaboration between the research stations and industry.

From work of this nature already carried out by D.S.I.R. the food industry has greatly benefited as, for example, from the researches carried out in the fruit and vegetable experimental hold at Ditton. At Torry similar scale work is in progress on the storage of fish in trawler holds and freezing on board ship. In all of these activities an essential feature was the prior field work on existing conditions, and, as in the case of refrigerated cargoes, the subsequent integration of field work and research. It cannot be too strongly stressed that what has been accomplished on these lines can also be effected in all branches of the food industry, given full co-operation. The high standard of engineering efficiency in the milk industry is an outstanding example of the results of this type of co-operation. The new Ministry of Food experimental factory should itself provide a valuable nucleus for development and co-operation and could also perform a very useful function in the training of development engineers for the industry.

British Patent Claims

Fluidised-bed reactors

In a catalytic or adsorption process of contacting a gaseous fluid with a bed of fluidised solids having a ratio of depth to diameter less than 1, supported on a grid having not more than 10% open area, the inflowing stream of gaseous fluid is divided into a number of smaller confined streams. These have no appreciable pressure drop and are discharged at at least three spaced points below the grid at a distance there-

FIG 1

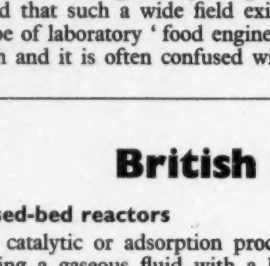
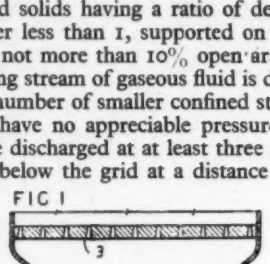


FIG 2



from sufficient to allow for the dissipation of the kinetic energy of the gas before passing through the grid.

In Fig. 1, the conventional conical base of a reactor contains an inlet pipe 4 divided into three pipes 5, the ends of which are preferably 1.2 metres below the grid 3. In a preferred embodiment, Fig. 2, the base of the reactor is elliptical and the branched pipes 5 are provided with valves 7. —659,048, *NV. de Bataafsche Petroleum Maatschappij*.

Hydrazine manufacture

Anhydrous hydrazine is prepared by reacting a hydrazine sulphate, preferably the acid sulphate with ammonia in the presence of liquid aliphatic ethers and/or alcohols having a boiling point under atmospheric pressure below 85°C., such as methyl, ethyl and isopropyl alcohol and diethyl ethers. The reaction is preferably carried out below 40°C. or at a higher temperature under increased pressure, and the hydrazine formed may be recovered by distillation of the reaction mixture after the solid residues have been separated.—652,855, *Mathieson Chemical Corporation*.

Oxalic acid from peat

Oxalic acid is obtained as a by-product in the preparation of peat wax from peat by adding dried peat slowly to concentrated nitric acid maintained at a temperature of about 60°C. After vigorous reaction has ceased, the wax is separated by filtration through a glass cloth. The solution remaining is maintained at 60°C. for a further period, cooled, decanted from solid impurities and crystallised. A yield of about 20% of oxalic acid is thus obtained. —647,693, *Minister of Supply*.

World News

GREAT BRITAIN

Chemical works safety conference

The 5th Chemical Works Safety Conference, which will take place from the afternoon of Friday, November 5, until the morning of Sunday, November 7, 1954, will be on novel lines. Instead of the usual method of presenting and discussing papers, it will consist of works visits to Wilton and Billingham, where, by the courtesy of Imperial Chemical Industries Ltd., safety methods and devices will be seen in practical operation. This conference should, therefore, be of particular interest to works managers, plant superintendents and others responsible for production as well as to safety officers. Full details are available from the Association of British Chemical Manufacturers, 86 Strand, London, W.C.2.

Steam plant for atomic power project

Jointly with the Department of Atomic Energy, Babcock & Wilcox Ltd. have designed the steam-raising plant for the first atomic power station in the U.K., and have been entrusted with the manufacture and construction of the plant to be erected at Calder Hall, Cumberland. This was announced by the chairman of the company, Mr. W. Lionel Fraser, in his annual report. He also stated that the sum expended in re-equipping and modernising the company's works during the last six years, together with those of the subsidiary companies in the U.K. and overseas, has almost reached £7 million.

Furnaces for uranium factory

Details are now released of an order, valued at over £500,000, placed by the Ministry of Supply with the General Electric Co. Ltd. The equipment ordered is used at the Dryway plant, Springfields, near Preston, in the production of uranium metal and comprises 54 vertical cylindrical furnaces, each rated at 100 kw., and 200 furnace pots. This order for furnaces is believed to be the largest ever placed at one time in any part of the world. The furnaces have been supplied complete with control and unloading gear, and cranes. They have a heated depth of 6½ ft. and a maximum temperature of 750°C. Forced air cooling is provided for the furnace pots, which have a diameter of 3 ft. 5 in. and a depth of 7 ft. 1 in.

The processes for which these furnaces are used are those concerned with converting pure ammonium diuranate to metallic uranium and are characteristic of a metallurgical works. The diuranate is converted to the metal in two stages; in the first it is converted to pure uranium tetrafluoride by heating the powder in G.E.C. furnaces, reducing it, and then passing over hydrogen fluoride gas at the appropriate temperature; this results in the formation of solid uranium tetrafluoride. This fluoride is then removed from the furnace, mixed with chips of calcium metal in a mould, and fired, resulting in its reduction to metal. Some difficulty at first experienced with corrosion of the furnace linings and pipes used in this process has been overcome by using *Inconel*.

New company to make titanium tetrachloride

A new private company to make titanium tetrachloride, Titanium Intermediates Ltd., has been formed by British Titan Products Ltd. and Peter Spence & Sons.

British Titan Products, the largest producer of titanium oxide outside the United States, has an issued ordinary capital of 3 million £1 shares, of which Imperial Chemical Industries, Imperial Smelting Corporation and Goodlass Wall & Lead Industries each hold 910,710, the remaining 267,870 being held by R. W. Greeff & Co. Peter Spence & Sons, of Widnes, is a private concern.

B.O.C.M.'s new oilseed extraction plants

The closure of the company's Anglo-American pressing plants at Rockvilla, Glasgow, and Gloucester marks the end of an era in seed crushing as far as British Oil & Cake Mills Ltd. is concerned, said the chairman of the company in his annual review. This type of equipment has been the mainstay of the crushing business since the company was first formed, but there has been a steady change-over to expelling or extraction during the past 10 years. Additional expelling units at Greenock and Avonmouth have replaced the production of Rockvilla and Gloucester.

Another historic occasion for the company was the closing of the castor extraction plant at Homco, in Hull, which was erected in 1885 and was the first successful extraction plant to be built in the United Kingdom. A modern plant is being built at Hull to replace it.

Plans for extensive increases in compound manufacturing capacity both at Avonmouth and at Silvertown, London, are in course of development. The company's new plants at Manchester and Renfrew are in full operation.

Seed crushing. The company continued to operate its seed-crushing mills and extraction plants on a tariff basis for account of the Ministry of Food, for whom the company's vegetable oil refineries and hardening plants also worked. The throughput of seed was at the same low tonnage level, compared with pre-war, as in 1952. Due, however, to the processing of high-oil-yielding seeds and nuts, mainly from British West Africa and the British Pacific Islands, the production of vegetable oils remained higher than pre-war and it continued to be disposed of mainly according to Ministry instructions.

Following the decontrol of linseed, soya oil and maize oil were added at the end of the year to the growing list of unrationed oils and, on May 8, the company's manufacturing and selling operations were finally freed from controls. A considerable increase in the export of crude and technical oils took place in 1953, but the export of refined edible oils suffered a reduction, being still prohibited except for approved Colonial allocations.

Nuclear power 'an ordinary problem of chemical manufacture'

In 10 years' time Britain should be building nuclear power plants which were reasonably competitive with conventional power stations. This prediction was made by Sir Christopher Hinton, F.R.S., Deputy Controller of Atomic Energy, at the annual luncheon of the Institute of Fuel held in London recently. He doubted if we could go on burning hydrocarbons, because they were a valuable source of chemicals. Fissile material was the obvious alternative fuel. The plutonium separation processes were extremely complicated and these were typical of the formidable problems of producing power from the atom. However, these problems were comparatively no more difficult than those which faced the early steam pioneers. Already chemists and engineers in the Atomic Energy Establishment were beginning to regard their work as an ordinary problem of chemical manufacture.

The power plant being built in Cumberland would supply important quantities of electricity to the national grid at about 1d./unit. This was 50% dearer than the power from a conventional station, but the initial capital costs were included in this charge and, of course, these costs would gradually fall.

Sir Christopher Hinton was emphatic that industry must be increasingly brought into the manufacture of nuclear power plants. The atomic energy organisation was not intended to manufacture conventional types of plant but to carry out work on new types of plant. The British Electricity Authority should build the conventional plants, using the services of industry. Finally, the speaker suggested that nuclear power was so important that the Institute of Fuel should form a separate division on nuclear energy.

The speaker was introduced by the President of the Institute, Dr. W. Idris Jones, of the National Coal Board. Also present was Dr. H. H. Storch, of the American Cyanamid Co., who is this year's Melchett Medallist.

Change of address

The Institution of Production Engineers has changed its address to 10 Chesterfield Street, London, W.1 (Grosvenor 5254/9).

Process Plants—B.C.P.M.A. Study U.K. Facilities

The ability of the British chemical plant industry to contract for complete process plants, as regards both scope and competence, is greater than is sometimes assumed in uninformed comparisons with the industries of Germany and the U.S.A. This was shown in an investigation carried out recently by the British Chemical Plant Manufacturers' Association, who obtained returns from members concerning processes for which complete plant could be designed and engineered, or engineered from process flow-sheets, or engineered from basic plant design data.

Among other activities of the B.C.P.M.A. during 1953, mentioned in the Association's annual report, was the appointment of representatives to a further six technical committees of the British Standards Institution. Work begun during the year includes the preparation of a code for glass-lined pressure vessels; of standards for bursting discs, dimensions and qualities of chemically-resistant bricks and tiles, manhole covers and cover plates; and of a standard for sizes of trade and technical literature.

Standardisation

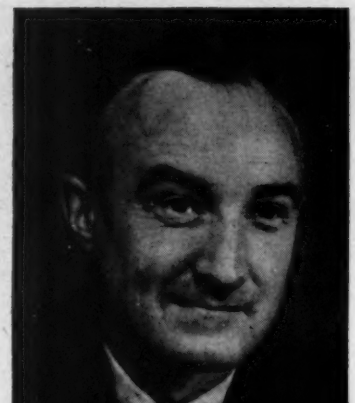
Arising from an examination of the report 'Chemical Apparatus in the U.S.A.', the Association and the Association of British Chemical Manufacturers set up a joint committee last April to investigate the need for and possibilities of a greater measure of standardisation and simplification of chemical plant and equipment. This committee is now discussing such problems as standard codes of performance and tests for plants, sizes of process vessels and the standardisation of fittings such as sight glasses, manholes and charging holes, with a view to making proposals to the British Standards Institution.

Chemical engineering research

The need for further support for the Higher National Certificate courses in chemical engineering, and export problems, were among other matters to which the Association gave attention.

Officers and Council for 1954

The names of the new chairman and vice-chairmen were given in our May issue. The full list of officers and council members is as follows: *Chairman*, Mr. W. J. Hooton (S. H. Johnson & Co., Ltd.). *Vice-Chairmen*, Mr. H. W. Fender (Prodorite, Ltd.); Mr. I. M. O. Hutchison (Henry Balfour & Co., Ltd.); Mr. R. F. Stewart (Dorr-Oliver Co., Ltd.). *Hon. Treas.*, Mr. P. W. Seligman (A.P.V. Co., Ltd.). *Other members of Council*, Mr. W. R. Beswick (Ashmore, Benson, Pease & Co.), Mr. B. L. Broadbent (Thomas Broadbent & Sons, Ltd.), Dr. G. E. Foxwell (Clayton, Son & Co., Ltd.), Mr. E. S. Franklin (Torrance & Sons, Ltd.), Mr. K. Fraser (W. J. Fraser & Co., Ltd.), Major V. F. Gloag, M.C. (Simon-Carves, Ltd.), Mr. A. G. Grant (Whessoe, Ltd.), Mr. J. C. Haithwaite (John Thompson (Dudley), Ltd.), Mr. G. N. Hodson (Hathernware, Ltd.), Mr. A. M. Hutcheson (Thompson Brcs. (Bilston), Ltd.), Dr. R. Lessing (Hydronyl Syndicate, Ltd.), Mr. J. Arthur Reavell (Kestner Evaporator & Eng. Co., Ltd.), Mr. G. W. Riley (George Scott & Son (London), Ltd.), Mr. R. W. Rutherford (Power-Gas Corporation, Ltd.), Dr. R. Seligman (A.P.V. Co., Ltd.), Mr. E. Smyth (Peter Brotherhood, Ltd.), Mr. J. W. Wright (Cannon (CP), Ltd.), Mr. Mark Wyndham (Bennett, Sons & Shears, Ltd.), Mr. H. V. Yorke (Bennett, Sons & Shears, Ltd.).



Mr. W. J. Hooton.
New chairman of B.C.P.M.A.

'Super-purity' aluminium

British Aluminium Co.'s oldest reduction works at Foyers, which has been producing aluminium for nearly 60 years, is being converted to the production of 'super-purity' aluminium. The company produces this material at Vigeland, in Noway, and have now the largest output in the world. In his annual review, the chairman of the company said that the process involved was a complicated one requiring long experience for its successful operation, and the company supply overseas producers as well as users.

The company's hydroelectric reduction works at Lochaber, Kinlochleven and Foyers operated at full output as far as possible during the year, but low rainfall during the summer necessitated some curtailment of production. The company were able to make up a proportion of this by purchasing power at Kinlochleven, but only at a very high price. However, production of ingot metal was approximately 3,000 tons in excess of that achieved in 1952.

Monsanto sell more and build new plants

Further increases in production capacity and process improvements for synthetic phenol, chemicals for the rubber industry, herbicides for agricultural weed control and facilities for the production of additional vanillin flavouring, at the Ruabon works of Monsanto Chemicals Ltd., are mentioned in the chairman's statement for the year. A building was also completed and equipment installed to provide a major pilot-plant unit for accelerating the commercial development of promising new products.

The chairman also recalled that, at the Newport (Mon.) factory, plants for the production of chemicals for use in synthetic detergents were expanded and revised. Two major expansions were made in the *Lustrex* (polystyrene plastics) plant to increase its capacity and to enable the company to offer a wider range of coloured moulding material to cater for the ever-extending variety of consumer demand. Other expansions, embodying new technology, were completed in units for the manufacture of chemicals for lubricating oils and for the manufacture of electrolytic chlorine and organic chemical specialities.

Capacity for producing silicon tetrachloride has also been increased by the installation of additional retorts and extensive technical work has gone into the improvement of *Silester O*, an organic silicon chemical used in the refractories and certain casting industries. In addition, the new soil conditioner, *Krilium*, was produced in tonnage quantities at this factory.

Overseas expansion. In Australia, new manufacturing projects completed during the year include a plant at Melbourne to produce polystyrene plastic for the first time in Australia. A project is nearing completion for the production of pentachlorphenol wood and paper preservative and control chemical. The early manufacture of the herbicide known as 2-4: D, which has several uses in the same field, is also projected.

Styrene. Forth Chemicals Ltd., in which Monsanto have a one-third interest with British Petroleum Chemicals Ltd., which is jointly owned by Anglo-Iranian Oil Co. Ltd. and the Distillers Co. Ltd., is now in full commercial operation and serving a ready market. Commissioning of the styrene plant of this company at Grangemouth had commenced at the end of 1952. During the first months of 1953 it was brought into full operation. The plant has since continued at better than design capacity, its output providing for the first time a United Kingdom bulk source of styrene monomer. The quality of the material produced has been highly satisfactory and Monsanto have used large quantities of it for the manufacture of *Lustrex* plastics and other products. A decision has been taken by Forth Chemicals Ltd. to proceed with the expansion

project referred to in Monsanto's chairman's previous reports, which will double the capacity of the plant.

Uganda phosphate. Tororo Exploration Co. Ltd., in which Monsanto have a one-third interest, was formed in 1953 in association with Uganda Development Corporation Ltd. and Frobisher Ltd. This company is attempting to develop economic methods for the working up and utilisation of important phosphate deposits in Uganda, with which is also associated the rare metal niobium. By the end of 1953 the extent and richness of the deposit had been fully established, and much of the research on ore beneficiation had been completed. This development might well result in the first sterling source of supply of certain very important minerals, but first there are important problems to be solved.

Sales up by 9%. Monsanto's sales during the year increased by 9% to reach the record total of £10,852,854, whilst direct exports, which amounted to 40% of total sales, were also a record at £4,320,000. There has been a downward trend in the selling prices of several major groups of products, but this has been more than offset by increased sales volume, by the consequent higher and more efficient levels of operation at the factories and by some lower raw material costs. As a result the net profit amounted to £670,860, an increase of 128% over 1952.

New catalytic cracking unit at Coryton refinery

The air-lift *Thermofor* catalytic cracking unit—the final unit to be built at Vacuum Oil Co.'s new refinery at Coryton—is now in production. This 300-ft.-high plant, the first of its kind in the United Kingdom, is now producing high-octane petrol stocks.

The T.C.C. is the most interesting and important unit in the manufacture of motor spirit. It takes gas oil and other components from both stages of the distillation unit and from other units of the refinery, and cracks the molecules of which these are formed into separate components consisting of motor spirit and fuel oil.

The unit operates by introducing the heated gas oil into a catalyst chamber. After leaving the reactor, the cracked products are separated in a fractionating column. The synthetic catalyst is regenerated in a stream of hot air in a separate vessel at the bottom of the unit. It is then blown by air through a pipe nearly 300-ft. high to the top of the unit, and then falls again by gravity through the stream of charge stock in the reactor. The whole process is continuous.

New office

F. Haworth (A.R.C.) Ltd., chemical engineers, have opened a London office to cope with increasing business from the London and Southern Counties area. The address is 40 Buckingham Palace Road, S.W.1 (telephone: Tate Gallery 3861).

I.Chem.E. Medal awards

The Osborne Reynolds Medal for 1953 was awarded to Mr. E. F. Mactaggart in recognition of his many services to the Institution and especially as hon. business manager for the 'Transactions.' The Moulton Medal for 1953 was awarded for the paper 'Liquid-Liquid Extraction, Part VIII: The Extraction of Uranyl Nitrate in a Wetted-Wall Column,' by Mr. R. Murdoch and Dr. H. R. C. Pratt. The Hinchley Medal was awarded to Mr. Harry Brody, who took the highest place in the Final (Eng.) (Chem. Eng.) Examination in 1953 at the Imperial College.

The committee set up under the chairmanship of Prof. F. H. Garner, O.B.E., to advise the council on policy with regard to the report of the Committee on Chemical Engineering Research, was instrumental in the formation of a joint committee with the D.S.I.R. to consider the correlation and distribution in suitable form of information on crushing and grinding in accordance with recommendations contained in the report.

Steam utilisation conference

The 21st annual engineers' conference of Spirax-Sarco Ltd., held at Buxton, lasted four days. The programme was in three parts: the latest product developments; the firm's technical contribution towards a higher productivity in steam and hot-water processes; and commercial expansion at home and abroad.

Whilst the technical discussions ranged over a wide field of process steam usage, particular attention was given to problems in the milk industry and the brewing industry and in those industries where steam-heated cylinder-drying machines are major items of plant. In addition, there were lectures on discussions on water blending for process and heating; on improved steam and hot-water methods at hospitals and laundries.

The conference was attended by representatives and associates from Denmark, France, Holland, India, Norway, Portugal and other overseas territories, as well as the firm's technical and engineering staffs and members of the commercial departments at home.

The chair was shared by Mr. H. Alwyn Smith and Mr. L. G. Northcroft, O.B.E., joint managing directors of the company.

Course in heat transfer

A short vacation course in heat transfer and related topics is to be held at Loughborough College of Technology from July 19-31, 1954, inclusive. It is considered that the course would be of great benefit to plant operators in the chemical industry, to junior design engineers and also as a refresher course for graduates or Higher National Certificate staff whose basic training in heat transfer needs consolidation on a practical basis.

The inclusive fee for the course is 20 guineas, but for students living locally who would not require accommodation in hall of residence or midday meals the fee would be 12 guineas.

The number of students attending will be limited to 30. Registration may be effected either by completing a form obtainable from the college or by an official letter from the firm nominating the student.

Record order for steel pipe

The contract for over 350 miles of 16-in. seamless pipe for the Sui, Pakistan, natural gas project—referred to on another page in this issue—has been awarded to Stewarts & Lloyds Ltd. The order involves a tonnage of over 40,000 tons and the value exceeds £2 million. It is one of the largest individual orders for steel pipe ever to be placed in the United Kingdom and was obtained in face of world competition. Shipments to Karachi will commence in about a month's time and the whole of the order will be supplied from Stewarts & Lloyds' modern seamless mill in Scotland.

TURKEY

More acid made

Production of sulphuric acid rose from 13,500 to 23,154 tons between 1950 and 1953. Production of coke rose from 314,800 to 548,700 tons, pig iron from 113,500 to 213,500 tons and steel from 90,800 to 162,600 tons.

FRANCE

New tanning process

Two French chemical firms have patented a new process for speeding up tanning operations which at the same time is said to make leather as resistant to wear as plastic. It involves the use of a vegetable tan extract added to zirconium.

A new company—Le Cuir Z—has been set up to tan leather by the new method.

GERMANY

Refining capacity increased

With the recent commissioning of a new combined atmospheric and vacuum distillation unit at Anglo-Iranian's B.P. Hamburg refinery, the A.I.O.C. Group's refining capacity in Germany has been raised to 1,440,000 tons/year. B.P. Hamburg refinery now has a capacity of 1,240,000 tons/year (last year it was 700,000 tons), while the Group's nearby Schindler refinery has a capacity of 200,000 tons.

Marketing and refining in Germany are handled by Anglo-Iranian's associate, B.P. Benzin-und Petroleum G.m.b.H.

PHILIPPINES

Sulphuric acid import restrictions

The Monetary Board of the Central Bank has passed a resolution restricting the importation of commercial sulphuric acid. One firm alone, the Chemical Industries of the Philippines, produces an average of 10 metric tons/day of commercial sulphuric acid, and this is more than enough for the islands' needs. A saving of over a quarter of a million dollars is expected.

CHILE

Chemical and metal projects

Sulphuric acid. The Corporacion de Fomento de la Produccion has announced the allocation of U.S. $130,000 for the purchase of machinery for the new sulphuric acid plant now under construction in Antofagasta. Estimated production is expected to reach 30 tons/day.

Lithopone. A plant for the manufacture of lithopone was opened in San Felipe (near Santiago) recently. This plant is reported to be capable of producing lithopone for paints at the rate of 5 tons/day. It is said to have cost Ch. $100 million, which has been partly subscribed by the Corporacion de Fomento de la Produccion and the balance by the Cia. Minera e Industrial de Bellavista S.A. It employs 70 workmen. The ingredients for the manufacture of lithopone—zinc and barium—are found in Chile in sufficient quantities and when in production this plant will represent a saving of about U.S. $500,000 a year in foreign exchange.

Lime. The local Press reports the formation of a firm having for its object the establishment of a factory in Talcahuano for producing lime for farming and industrial purposes, utilising as its raw materials calcium carbonate from Guarello Island.

Aluminium. An aluminium manufacturing plant which is going into production is expected to meet the domestic needs of the country, estimated at 2,200 tons p.a.

Beet-sugar plant

A new beet-sugar processing plant has been inaugurated at Los Angeles, about 600 km. south of Santiago. The plant, the first to produce sugar from Chilean domestic sources, will turn out about 20,000 tons p.a., representing approximately 12% of the quantities of raw sugar usually imported from Cuba, Peru and Ecuador.

First oil refinery nearly complete

An important addition to South America's oil economy, Chile's first refinery, is rapidly taking shape about ten miles north of the city of Valparaiso. Owned by Empresa Nacional del Petroleo, the refinery is expected to be completed late this summer. Construction is under the supervision of Kellogg Pan American Corporation, and includes the power plant and all principal off-site facilities as well as all process units.

The refinery will have a capacity of 20,000 b.p.d., will utilise the most modern combination thermal processing equipment and will process both native and imported crudes.

Facilities in the combination unit comprise atmospheric distillation, vis-breaking, thermal reforming, thermal cracking, gasoline stabilisation, and sulphur removal from fuel gas, liquefied petroleum gases and gasoline. Products from the plant will include, in addition to L.P.G., motor gasoline, tractor gasoline, kerosene, two grades of diesel oil and heavy fuel oil.

The Leonard Hill Technical Group—June

Corrosion Technology — Cathodic Protection, 2; Paint versus Corrosion; Prevention of Corrosion by Water; A Year's Corrosion Research at the C.R.L., B.I.S.R.A. report; Electrochemical Derusting.

Manufacturing Chemist—Ointment Bases, 1; Adrenocortical Hormones, 3; Rauwolfia B.P.C.; British Cortisone Plant; Plant Growth Substances; Progress Reports on Perfumery, and Antibiotics.

Atomics—The Determination of the Energy of Proton Gamma Resonances and their use to check theories of Nuclear Structure, 1; Nuclear Reactors and Power Production, 3.

Food Manufacture—Quick Freezing in France; Hygiene in Meat Manufacture; Microbiological Problems in Food Preservation in the Netherlands; Scientific Research in Britain.

Paint Manufacture — Stirrer Efficiency; Carbon Black for Surface Coatings; The Colloid Mill for Emulsion Paints; Paint for High Moisture Conditions; Emulsion Paint Systems.

Fibres (Natural and Synthetic) — Practical Aspects of Shrinkproofing Wool; 'Ardil' Fibre from Groundnuts; The Requirements of Dyeing and Finishing Chemicals for Use with Cellulose Acetate Fibre; Calcium Alginate Fibres.

World Crops—Investigations in the Control of the Olive Fly in Italy and Greece; Increasing the World's Food Supply—The Domestication of Fish; Agriculture in Iceland; Mechanical Handling, 1.

Building Materials Digest—Stone for the Rebuilding of Cities; Decorated Prefabricated Walls; Forecast of Building Projects.

Muck Shifter—Excavation and Constructions to Preserve Niagara.

Petroleum—Refinery Management in the United Kingdom; Refinery and Installation Less Control; Economic Influences and Refinery Location.

CANADA

$20-million refinery

Construction has started on a complete $20-million refinery for the new oil company, Canadian Petrofina Ltd., scheduled for completion in the latter half of 1955.

Kellogg was recently awarded the contract for the design of the major part of the processing units and their wholly-owned subsidiary, Canadian Kellogg Co. Ltd., will erect the units and all of the off-site facilities. The refinery will be located near Montreal, the major refining area in eastern Canada.

Much of the new plant will be of integrated combination design, eliminating considerable intermediate storage. It will also be designed with flexibility to handle both Middle East and Venezuelan crudes. Processing facilities to be built by Canadian Kellogg include a 20,000-b.p.d. topping unit, vacuum flashing capacity of approximately 10,000 b.p.d., a 4,000-b.p.d. vis-breaking unit, a 3,600-b.p.d. catalytic reforming unit, catalytic polymerisation and alkylation units with feed desulphurisation facilities, 2,500-b.p.d. distillate treating unit and a 6,500-b.p.d. gasoline treating unit.

Off-site construction will include a steam generating plant, a cooling water system, wharfage for tankers, crude oil and product storage, an office building, shops, and extensive marketing facilities such as truck, rail and barge loading installations.

SOUTH AFRICA

Uranium and acid plants

By the end of last year £4,368,924 had been spent on the Daggafontein Mines' uranium and acid plants, according to the chairman's annual report. This, with £209,800 accrued interest payable under loan agreements, brought the total expenditure to £4,578,724. The net profit from the production of uranium and acid during the year has been estimated at £644,991, which is subject to adjustment. Such adjustments as are necessary will be brought into the accounts for 1954. The final estimated cost of the uranium and acid plants is £4,338,000, excluding interest on the loans. Repayments of loans will begin this year. At December 31, £399,000 had been advanced to the company under the loan agreements.

Application had been made for further loan facilities to cover the additional funds required. The directors are asking that their borrowing powers be increased from £4 to £4¾ million, which should be sufficient to cover the total loan facilities required to finance the cost of the plants and to provide a margin for any temporary borrowing that may be necessary. As the uranium capital programme was practically completed in 1953, there will in future be substantial decreases in the annual redemption allowance.

Sea-salt plant

The Vrany Salnova Works Ltd., Coega, Port Elizabeth, expect very shortly to be producing 100 tons/day of refined salt from the sea. This company has taken over the Vrany Chemical Corporation of S.A. Ltd., which was started several years ago. The new company has provided a new £100,000 refinery at the mouth the Coega River. The salt pans there prepared by the previous company are being retained.

The new plant is claimed as the first of its kind in the Southern Hemisphere and is designed to produce salt of a purity of 98.5 to 99.7% sodium chlorate. The company announces that it can supply salt in any size of crystal and to specification for industrial and other purposes. The works at Coega have been producing salt for over five years, but considerable expansion is expected as a result of new developments. The Union can now produce salt of a purity demanded by a number of industries, which previously had to import salt to their specification.

Pulp plant for rayon works

A group of specialists from an associate company of Italy's Snia Viscosa is to work on the construction of a dissolving pulp plant at Umkomaas, near Durban. The plant is to produce dissolving pulp from eucalyptus wood and is expected to turn out between 40,000 and 50,000 tons/year.

Scheduled to begin production in 1955, the plant is a joint enterprise of Courtaulds Ltd. of England, Snia Viscosa and the Industrial Development Co. of South Africa.

BURMA

Drugs, alcohol and yeast projects

Considerable progress has been made in the establishment of the pharmaceutical industry for the Burmese Government which is being undertaken at the cost of several millions of pounds by Evans Medical Supplies Ltd., of Liverpool, who are acting as agents. On April 23 the foundation stone was laid for the main pharmaceutical factory by the Prime Minister of Burma. The site is different from that originally chosen. It is on the Hlang River, about eight miles from Rangoon, and consists of 140 acres.

Plant units. The buildings will cover 250,000 sq. ft. and will consist of:

(1) A main pharmaceutical factory comprising raw material store, drug grinding, galenical and tablet manufacture, filling rooms and sterile products laboratories.

(2) A biological institute for the preparation of sera and vaccines.

(3) An alcohol distillery capable of an output of 2,400 gal./day. Varying types of alcohol will be produced according to demand. Raw material will be inferior-grade rice and 1,000 tons/month will be needed.

(4) A yeast plant providing ½ ton of dry medicinal yeast per day, for distribution as tablets.

(5) Administrative buildings, comprising offices, canteen and laundry, together with workshops, garages and a boiler house and generator station.

(6) Farm buildings for large and small animals required for vaccine and sera production and for biological testing.

The buildings will largely be of metal units prefabricated in Great Britain.

The river Hlang will be linked with the site by railway, and on the river side will be a pumping station, effluent discharge plant and rice stores.

Products. The products to be made by the Burma pharmaceutical industry include sera and vaccines for many diseases such as smallpox, tetanus, diphtheria, gas gangrene, typhoid, cholera and rabies. A wide range of standard drugs in the form of extracts, tinctures, ointments, tablets, etc., will be manufactured, using, where possible, indigenous drugs such as opium, ginger, nux vomica, cinchona, squills, aurantium, belladonna and cardamoms.

Great importance is placed on the alcohol and yeast plant and machinery, and equipment and engineering work is being undertaken by the A.P.V. Co. Ltd., London, while technical know-how for yeast manufacture is being supplied by Fermzymetera S.A., Luxembourg.

It is hoped that within a year production will be started in the main pharmaceutical factory on a temporary basis, employing up to 100 workers. A feature of this building will be a three-storey tower for the grinding of drugs. On the top floor there will be ten kinds of machinery for grinding the various crude drugs, after which they will flow by gravity to percolators.

The technical staff are working under great difficulties, as there are no pharmacists in Burma and no school of pharmacy. On the site itself there is no water and wells are being bored. Also, there is no electricity and a diesel generator is being installed.

AUSTRALIA

£11-million orders for Kwinana refinery

Orders worth more than £11 million have been placed with British, Australian and American manufacturers for materials for the 3-million-ton/year Kwinana refinery being built near Fremantle by Anglo-Iranian's Australian associate, Australasian Petroleum Refinery Ltd. British and Australian orders each total £4½ million, while an additional £1½ million has been spent with Australian firms who subcontracted for preparatory and building work on the site.

Of the 100,000 tons of materials and equipment estimated to be required for building the new refinery and port, about 75,000 tons have already arrived by sea at Fremantle and have been transported overland to Kwinana. Although much of the material for the various refining plants has been purchased in either the United Kingdom or the United States, a larger proportion than was at first expected of steel plate for tankage, steel piping and other equipment has been available in Australia.

Uranium mining

The Australian Government has let a contract to the British firm of George Wimpey & Co. for extensive open-cut uranium mining at Rum Jungle, Northern Territory, according to Mr. Howard Beale, the Supply Minister.

The Atomic Energy Commission, he said, on the recommendation of the Consolidated Zinc Corporation, which was operating the Rum Jungle project for the Government, had decided on open-cut mining instead of deep mining, which was presenting considerable geological difficulties.

Mr. Beale also announced that the Rio Tinto Co. had entered the search for uranium in the Northern Territory. The company, he said, had been granted prospecting rights in a certain area of the territory.

UNITED STATES

$100 million for chemical plant expansion

The Allied Chemical & Dye Corporation plans to spend $100 million for plant expansion and improvement in 1954, against $135 million in 1953.

The company, reporting the highest first-quarter sales ever recorded, said declines in activity in steel, motors and textiles had affected sales, but this was overcome by increased operations in nitrogen products and in plastics. While general business was running at levels which prevented the use of facilities to capacity, the company felt certain that added plant capacity would be needed later.

A new plant of the Nitrogen Division recently started running in Nebraska and a unit to make urea would be in operation soon, the company said. By the end of the summer, it was expected that the raw materials plant for a new Allied nylon-type fibre would be running and fibre output was expected to start in the autumn.

Polyester film plant

The du Pont Co. expects to open its first commercial plant for *Mylar* production this summer at Circleville, Ohio. This material is a polyester film which the company regards as an entirely new substance that will find applications other than those for which transparent cellulose sheet and other commercial films are most suitable. Electrical insulation appears to be one of the most promising. A thin layer of aluminium can be deposited on *Mylar* and the resultant mirror-like film laminated to a fabric backing to form decorative material for use in upholstery, shoes and pocket-books. Acoustic tile made with it retains design colours for years and improves soundproofing, it is claimed.

Ammonia project

The Mississippi River Fuel Corporation is planning to set up a 200-tons/day ammonia plant to produce anhydrous ammonia, nitric acid and ammonium nitrate. The plant is estimated to cost $15 million and it will be located on the Mississippi River.

Acetylene chemicals plant

The General Aniline & Film Corporation is to build a $6-million plant at Calvert, Kentucky, for manufacturing high-pressure acetylene derivatives. These products, which are used for making a wide range of chemicals, are at present being produced in the U.S. only on a pilot-plant scale by the company at Linden, New Jersey.

The new Kentucky plant is expected to be in operation by the end of 1955 and will be capable of expansion. General Aniline purchased a number of patents in the high-pressure acetylene chemistry field from I. G. Farben in 1940 and has since spent several million dollars on research.

★ PERSONAL PARAGRAPHS ★

★ **Mr. K. B. Ross,** O.B.E., who until 1951 was general refineries manager for the Anglo-Iranian Oil Co. at Abadan, and has since then been on the board of Costain-John Brown Ltd., has been appointed director of production in the Industrial Group of the Department of Atomic Energy at Risley. He is 53 and he joined the Anglo-Iranian Oil Co. in 1926 as a junior development chemist. In 1933 he went to Persia as senior development chemist and was progressively promoted to works manager in 1946. In 1951 he became general refineries manager and was in charge of the last party to leave Abadan in October 1951. He joined Costain-John Brown in 1952.

★ **Mr. P. T. Fletcher,** chief engineer of the Ministry of Works, has been appointed deputy director (engineering services) in the Industrial Group of the Department of Atomic Energy. He is 42 and was trained as a general engineer in the firm of E. A. Gardner & Sons Ltd. (of which his father was proprietor) until 1932, when he took his B.Sc.(Eng.) degree. He entered the Civil Service in 1939 through open competition as an assistant engineer and has been with the Ministry of Works since then.

★ **Dr. Basil F. J. Schonland,** C.B.E., F.R.S., who is at present head of the Bernard Price Institute of Geophysical Research in the University of the Witwatersrand, is to be appointed deputy director of the Atomic Energy Research Establishment at Harwell. The appointment will take effect towards the end of 1954. He is 58, married and has one son and two daughters. From 1922-36 he was lecturer and later Professor of Physics at the University of Cape Town; in 1937 he was an Halley lecturer at the University of Oxford.

From 1941-44 he was brigadier, South African Corps of Signals; superintendent, Army Operational Research Group (Ministry of Supply); and brigadier (scientific adviser) to C.in-C., 21st Army Group, British Liberation Army. From 1945-50 he was president of the South African Council for Scientific and Industrial Research.

★ **Mr. H. S. Wingate,** vice-president and a director, has been elected president of the International Nickel Co. of Canada Ltd. He has also been elected to membership on the executive committee of the company and to the presidency of its United States subsidiary, the International Nickel Co. Inc. At the same time, **Mr. F. M. A. Noblet,** assistant treasurer, was elected treasurer or the parent company and also treasurer of its U.S. subsidiary.

★ **Mr. M. M. Hallett,** M.Sc., F.I.M., has been appointed director of research to three Sheepbridge Group companies, Sheepbridge Stokes Ltd., Chesterfield, Sheepbridge Equipment Ltd., Chesterfield, and Sheepbridge Steel Castings Ltd., Sutton-in-Ashfield, Notts. He will be responsible for the research and development laboratories at Sheepbridge Engineering Ltd., Chesterfield, the parent company, and also for the technical control of the Group foundries.

Sheepbridge Stokes Ltd. produce engine cylinder liners and centrifugal castings for the motor industry. Sheepbridge Equipment Ltd. manufacture quarry machinery, gyratory and jaw crushers, pan feeders and vibrating screens, fully automatic ceramic tile presses and plastic tile presses, etc. Sheepbridge Steel Castings Ltd. are the largest British producers of heat-resisting and stainless-steel castings for British jet and gas turbine engines.

★ **Mr. A. G. Thompson,** B.Sc., A.M.I.C.E., has been appointed by the British Welding Research Association to make an investigation into welding productivity. Mr. Thompson has been associated with the welding and metal fabricating industries for a number of years and has recently been engaged in investigations into product design and production problems with a group of companies in the heavy engineering industry.

★ **Lt.-Col. P. D. Ionides,** D.S.O., has resigned from the board of Babcock & Wilcox Ltd. after 26 years' service. **Sir Percy Mills,** Bt., K.B.E., and **Mr. W. F. C. Schaap,** the company's chief engineer, have been appointed to the board.

★ **Mr. J. Richmond** has been appointed London manager of Rhodes, Brydon & Youatt Ltd. and is responsible for the sales organisation in the London area covering both the heating, ventilating and industrial user fields. **Mr. C. W. Haydon** has been appointed technical representative to look after the firm's interests for pumps used for heating, ventilating and air conditioning. Meanwhile, **Mr. M. J. B. Hodgson** continues to look after the industrial user market.

Export Opportunities

Ghee manufacturing and oil expelling machinery

Okara Ice and Cold Storage Co., P.O. S.C. Mills, Lahore/Multan Road, Okara District (Montgomery), a firm at present engaged in refrigeration of potato seeds and fruits and ice making, desires to extend its activities to ghee manufacturing and oil expelling, and wishes to buy new machinery.

Agency enquiry for engineering goods

The United Kingdom Trade Commissioner at Johannesburg has reported that Mr. D. J. C. Nelson, B.Sc., M.I.H.V.E., head of the engineering division of Messrs. J. L. Clark & Co. Ltd., P.O. Box 7787, Johannesburg, has expressed interest in representing United Kingdom manufacturers of propeller fans for industrial application; axial-flow fans for mine application; C.I. sectional boilers for central heating (steam and hot water); automatic stokers (for industrial and central heating installations); circulating pumps for hot water; centrifugal-type water pumps generally; steam and hot-water accessories (traps, strainers, valves, etc.); and commercial and domestic light refrigeration units.

Mr. Nelson will be visiting the United Kingdom from about June 5-26 and is anxious to be in a position to proceed immediately on his arrival to contact firms interested in, but not already represented in, the Union of South Africa.

United Kingdom firms interested in this enquiry should submit full details of their products together with trade literature and price lists to the Board of Trade (see below) quoting ESB/10682/54.

For further details of these enquiries, write to the Export Services Branch, Board of Trade, Lacon House, Theobalds Road, London, W.C.1.

CHEMICAL & PROCESS ENGINEERING

ENQUIRY BUREAU

Stratford House, 9 Eden Street, London, N.W.1

Readers requiring names of suppliers of raw materials, machinery or finished products should complete this form and attach it to their business note-heading. Please state approximate quantities required.

We wish to know names and addresses of suppliers of the following:

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For office use only. No. Date